MARKET INTEGRATION AND HEALTH: THE IMPACT OF MARKETS AND ACCULTURATION ON THE SELF-PERCEIVED MORBIDITY, DIET, AND NUTRITIONAL STATUS OF THE TSIMANE' AMERINDIANS OF LOWLAND BOLIVIA

By

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MARKET INTEGRATION AND HEALTH:
THE IMPACT OF MARKETS AND ACCULTURATION ON THE SELF-PERCEIVED MORBIDITY, DIET, AND NUTRITIONAL STATUS OF THE TSIMANE' AMERINDIANS OF LOWLAND BOLIVIA

By

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Chair: Anthony R. Oliver-Smith
Major Department: Anthropology

Scholars have long been interested in the effects of markets and contact on the health of native populations. Greater integration into a market economy and exposure and assimilation into a dominant society can result in shifts in modes of subsistence, decision-making about resource use, and access to health-related goods and services. The clear direction of influence is often elusive. Increased income, material wealth and credit, predicts expanded access to goods and services that may directly and indirectly improve household and individual health. At the same time, greater involvement in market trade can shift economic priorities away from secure subsistence production toward the lure of material gain and novel items. Additionally, exposure to acculturative forces (such as formal education, language skills of the dominant society, and frequency of contact) can result in the adoption or rejection of new values and preferences.

The Tsimane' Amerindians of lowland Bolivia have been undergoing varying degrees of integration into the regional economy and society. The organization of their economic and social activities has been influenced by external forces from as early as colonial expansion. The Tsimane' people share many experiences with other native peoples of the Amazon who have responded in myriad ways to the encroachment, expansion, and opportunity of contact and articulation with a larger economy. The Tsimane' provide a suitable population among which to examine the relationship between markets and health.

Research on the health impacts of market integration and acculturation is important because health is a standard indicator of human welfare. This dissertation examines three components of health: illness episodes, household diet, and nutritional status. Using data from a panel study of two Tsimane' communities, I present descriptive and multivariate analyses of each of the three dependent measures of health as they relate to measures of integration into the market economy and acculturation.

Tsimane' household and individual integration into the market economy did not demonstrate strong effects on health status. The absence of statistically significant findings is explained in part by the observation that income and education alone are insufficient to improve health. Even with increased participation in the regional economy and society, constraints such as poor physical infrastructure, lack of political representation, and access to health care and knowledge remain despite increased opportunity for earning income and attaining education.

CHAPTER 1
MARKETS AND HEALTH

Markets and Indigenous Health

Introduction

Scholars have been interested in the effects of markets on human health for many decades (Godoy and Cardenas 2000; Gross et al. 1979; Leatherman 1994; Wirsing 1985). The relationship between markets and health has been studied from a variety of perspectives, yet scholars are still searching for a clear understanding of the nature of the relationship between individual health status and participation in a market-organized economy. Participation and integration in a market-economy are often gauged by measures of income, wealth, savings, and use of credit institutions. Within this broader research agenda lies a range of specific indicators of health, including frequency and type of illness (both perceived and objective), dietary adequacy, and nutritional status.

Two contrasting perspectives have been advocated in the literature on markets and the health of indigenous peoples. The first is that integration into a market economy improves health through access to higher incomes, formal education, and health-care services (Akin et al. 1985; Haddad et al. 2002; Holmes 1985; Kennedy 1994; Steckel 1995). Income and education are associated with the ability to smooth consumption, purchase medical services, treat illness promptly, and maintain proper sanitary conditions. Markets can also function as a safety net for fluctuating dietary intake during seasonal shortfalls in resource availability. Increases in household income can augment individual energy intake through improved access to food (Kennedy 1994). If so,

safeguards to dietary health would be evident in indicators of both long and short-term nutritional status.

The second perspective is that market economies are detrimental to the health of indigenous populations because market expansion is often accompanied by increased disease exposure and dietary alteration (Leatherman 1994; Leonard 1989). This perspective comes from an ecological approach that suggests traditional societies have adapted to their environments in ways that maintains good health and nutrition (McElroy and Townsend 1996; Wirsing 1985). While studying indigenous Andean peoples, Leatherman (1994) found that increases in cash income were accompanied by shifts in dietary diversity. As diversity increased, nutritional value decreased, because people replaced foods of high nutritional value with higher-calorie food items that were lower in nutritional content (Leatherman 1994).

Clearly, these contrasting perspectives indicate that a complex relationship exists between health status and measures of integration to a market system. While few remain, there are still relatively unacculturated and unintegrated groups living today. Indigenous peoples around the world are currently undergoing varying degrees of exposure to and integration into market economies. In many places, these people are not controlling or determining their own relationship with the market economy and are therefore in a disadvantageous position (Gray 1990). If researchers can identify patterns of similarity in what is happening as economic integration and social acculturation intensify, the findings can perhaps influence policy and programs that would mitigate any detrimental consequences for these native cultures and livelihoods. Research on the impact of market integration on the health of indigenous populations is important because health is a

standard and classic indicator of human welfare and robustness of the society. For these reasons, the objective of my study was to analyze relationships among integration to the market and indigenous perceived-morbidity, diet, and nutritional status. To achieve this objective, I studied a sample of Tsimane' Amerindians in two communities in the Bolivian Amazon who are experiencing varying stages of integration into a market economy.

Structure of the Dissertation

The dissertation is organized into nine chapters that guide the reader through the theoretical background and research questions, methods used to collect data in the field, and findings based on analysis of the data. Chapter 1 discusses the theory behind assumptions about market and nonmarket organized economic systems. Two related concepts important to understanding how indigenous peoples interact with market economies are *social acculturation* and *economic integration*. I examine how aspects of human health are subject to alteration through these processes of socioeconomic integration, drawing from scholarly research on the effects of markets on illness, diet, and nutritional status.

In Chapter 2, I present the research design and methodology used to collect data in the field. The methods reflect a variety of considerations including research objectives, plans for data analysis, facility in applying the methods accurately in a tropical setting, cultural appropriateness, cost, and human resource requirements. I describe the selection of the sample population, the structure of the data collection, and each of the surveys used in the field. Each method is accompanied by a brief discussion on possible limitations to its use in the ecological and social context of Bolivia's Amazon region.

Chapter 3 details the ethnographic background of the Tsimane' [chee mah nee] people, what is known of their genesis as a distinct ethnic group, and their social and economic organization in general. This includes their traditional social and economic institutions and a specific history of social and economic integration into the larger Bolivian society leading up to the study period.

Chapter 4 describes the specific marketplaces and economic activities of the Tsimane' people. I present summary statistics of measures of integration to the market, acculturation, and demographic characteristics from my sample of two communities. Chapter 5 discusses factors important to Tsimane' health, such as access to health resources, infrastructure, and behaviors to illustrate the constraints to health and welfare facing the two study communities.

While the first five chapters set up the necessary foundation for understanding the research questions, design, and ethnographic background, the next three chapters cover the data analysis and testing of each of the research hypotheses. Chapter 6 addresses self-perceived morbidity among the Tsimane'. I begin with a review of the relevant literature on markets, acculturation, and perceived health status, then describe the health of the Tsimane' people and variations within and between the two study communities. Finally, I test whether measures of integration to the market correlate with the frequency, severity, and type of self-reported illness.

Chapter 7 examines the household diet of the Tsimane' people. First, I review the literature on dietary transitions among indigenous peoples with special attention to consumption, availability, and seasonal variation in dietary intake as participation in a market economy and society intensifies. It is important to assess whether foods

purchased with income earned in market activities are adequate substitutes for home-produced diets. There is evidence that when households turn more to the market, the resulting cash income may be insufficient to meet nutritional needs. If a market diet is not economically accessible, the nutritional state of individuals in the population may worsen (Messer 1984).

Chapter 8 presents a review of the literature on nutritional status and analyzes measures of market integration, acculturation, and nutritional status (adult and child). Summaries of various measures of nutritional status inform us about body composition and biological responses to the environment. I also compare Tsimane' nutritional status with that of other Amazonian populations.

In the final chapter, Chapter 9, I discuss how the findings from each of the three analytical chapters apply to a broader context of integration to the market and human welfare. I consider explanations and interpretations of findings from this study. Given the socioeconomic alterations taking place throughout the Amazon region, there is a need for research that contributes to understanding whether this process of change is detrimental or beneficial to the overall mode of subsistence and welfare of groups like the Tsimane'. I conclude with suggestions for how future research on indigenous health, markets, and acculturation can be informed by my study.

Markets in General

The Tsimane' are a population with varying degrees of involvement in a market economy. Before discussing the possible effects on indigenous health, it is useful to understand the economic and social systems that provide the impetus and pressure to modify human behavior. I approach the analysis of markets and health using a

comparative framework of involvement in market- and nonmarket-organized economies and examine the impacts this behavior has on health.

Economic systems are distinguished by different principles that guide behavior for determining how scarce productive resources are used and allocated for consumption, distribution, and accumulation. Before discussing variations in economic involvement, I outline the principles of a market economy and contrast them with those of a traditional nonmarket economic system. The value-laden label of "traditional" often depicts societies as static and deficient in social and economic development, blinding the analysis to relationships among these constructed categories (Wolf 1982); but "traditional" in my study refers to historical patterns of behavior characteristic of native peoples in contrast to customs introduced from exogenous cultures. By nonmarket, I mean economies in which production and distribution are organized according to principles such as reciprocity and redistribution. I describe these principles later in this chapter.

Market Economies

A set of general principles structures market-oriented economic behavior. The market at its most basic definition is an institution of economic relations and exchange behavior. Institutions in this context are principles or rules that guide behavior. The elements of a market economy put forth by neoclassical economists include exchange relations, scarcity, and capital accumulation. Understanding these elements provides a foundation for the mechanisms through which integration and acculturation can affect social institutions and behaviors and thereby influence health.

Market exchange is characterized by the transacting of goods and services whose values, and/or prices, are determined by supply and demand (Johnson and Earle 2000). Money in Western market systems serves as a medium of exchange whose value lies in

the transaction. "Money allows value in a fixed form to be converted to value in any form" (Peterson 1991:13). In contrast, money in nonmarket systems has been described as having specific uses, for example, the exchange of livestock for marriage payment. A completely market-based economy mandates the acquisition of material livelihood through the selling of something, namely land, labor, or a commodity (Dalton 1971). Economic anthropologists have described market transactions as either atomized or embedded, depending on the level of tie or relation between the actors involved in the exchange (Granovetter 1985). The short-term profit-seeking exchanges typical of a market system do not foster personal relationships. Compared to reciprocal exchange institutions, this form of socioeconomic organization is impersonal and thought to comprise self-interested participants. This stands in contrast to reciprocal institutions and embedded exchange networks of nonmarket cultures organized for the purpose of establishing and maintaining social ties and insurances.

Another principle associated with economic behavior in a market system is the universal perception of scarce material resources (Dalton 1971). Perceptions of scarcity are the organizing causes of self-maximizing behavior in a market system. With capitalism, unlimited desires are the driving force of human nature responsible for the development of free markets in which actors seek to maximize personal gain (Graeber 2001). The idea that material needs are insatiable has been criticized as an attempt by neoclassical economists to naturalize a behavior and tie it back to a biological postulate (Dalton 1971).

From a different perspective, unlimited wants can be seen as socially constructed (Gowdy 1999). Sahlins (1972) challenged the idea of a natural component of human

behavior as having unlimited wants with insufficient means to satisfy. He wrote that "it is not that hunters and gatherers have curbed their materialistic 'impulses,' they simply never made an institution of them" (1997:13). Most of literature on hunter-gatherers and small-scale horticultural societies is filtered through the Western perspective of what defines success, productive capacity, and affluence. In the twentieth century, studies of indigenous economies were heavily influenced by the perspective of neoclassical economics. Formalist economic theory was built out of the analysis of capitalist market systems where livelihoods depend on capital generation (e.g., wage labor), competition for positions, self-maximizing behavior, and dependency. These concepts were then applied to noncapitalist societies (Graeber 2001; Heilbroner 1985).

Accumulation of capital is another essential element of a capitalist system. Furthermore, capitalism is understood as an expansive process (Heilbroner 1985) where the goal of social activities is to generate more capital. By contrast, precapitalist societies are described as amassing wealth for use, rather than for the regeneration of more wealth. Heilbroner (1985) discusses prestige as attributable to inherent qualities or talents of an individual. Prestige goods are inanimate objects that have the ability to increase the owner's prestige as seen by others. With capitalism, accumulation of goods translates into prestige for the owner.

Subsistence Economies

Small-scale subsistence economies are typically depicted as functioning according to reciprocal institutions of exchange (Sahlins 1972). A subsistence-level economy relies on production at the domestic unit to meet basic human needs, often biological needs such as food and water, as well as the technologies necessary to harness or produce these resources. In a subsistence-level economy, the producers, means of production, and

products are not separated (Gudeman 1978 in Dewey 1985). This contrasts with commercial production where goods are primarily destined for sale or trade.

It has been postulated that before the rise of the state and the entrenchment of social inequality, people lived for millennia in small-scale kin-based social groups, in which the core institutions of economic life included collective or common ownership of land and resources, generalized reciprocity in the distribution of food, and relatively egalitarian political relations (Lee 1988). This perspective emphasizes collective rights to basic resources in contrast to private property. It traces its roots to Lewis Henry Morgan, as a necessary ethos based on ecological and social constraints (Lee 1988). One of the main principles organizing subsistence economies is generalized reciprocity whereby material resources are given to group members without expectation of immediate return. Essentially, this institution serves as a long-term safety net during periods of resource scarcity and is aimed at smoothing consumption (Smith 1988). Reciprocity is also a type of leveling device, by way of cultural proscriptions against wealth accumulation and inequality. Reciprocity can be understood as a sharing ethos whose purpose is to establish and maintain social ties and insurances.

Analysis of Non-Western Economies

Indigenous peoples vary widely in their economic institutions and organization. Discussions of indigenous groups who have historically occupied tropical forests refer to certain economic and social formations of small-scale societies. Forager-horticultural is the organizational form addressed by my research. Populations still exist, predominantly in the tropics, that organize subsistence procurement through a combination of foraging and small-scale cultivation. We can study them to understand better how the process of economic and social integration impacts their welfare.

Conventionally, the study of the economic evolution of tropical populations places them along a continuum from subsistence-level to interdependent market-organized economies. This view is highly influenced by the historical interpretation of the rise of capitalism in Western Europe. Firth (1968) summarized features of non-Western economies to include the following: simple level of technology, small productive units, the absence of an expanding market for capital, absence of entrepreneurship, and different social conventions for control of capital goods (e.g., restrictions on wealth accumulation). It is evident that these features are contextualized negatively or as lacking Western market features. A dichotomous construction of capitalist and noncapitalist, or an evolutionary bias as precapitalist, negates the hybrid formations and variants in integrative processes (Cleary 1993). Anthropologists have played an important role in gathering empirical data to investigate whether small-scale societies are operating under market-defined decision-making and economic behaviors. However, there is often a limited time-scope or lens of historical analysis when we begin to study tropical populations. This, combined with a cultural evolutionary perspective that views societies as "developing" toward more complex forms of organization, casts an ethnocentric shadow over our understanding. Furthermore, there is a tendency to naturalize the historical development of a capitalist system and impose this interpretation on the analysis of foraging populations in an ahistorical manner (Dalton 1971; Lee and Daly 1999; Richards 1997; Wolf 1982; Wood 1999).

Scholars recognize and challenge the validity of the inclination to situate subsistence economies within a specific historical trajectory of another world region (Graeber 2001; Sahlins 1972). Dalton (1971) questioned whether a theory born out of a

specific form of economic system (capitalist) would be applicable to the analysis of other economic forms. Yet, these are the theories against which economies are analyzed. It is, perhaps, more useful to think of the range of transformations on this multidirectional path (that occur over time and place) as economic and social institutions adapt and respond to new stimuli.

Culture Change through Integration and Acculturation

Economic and social institutions undergo modification through contact with and integration into other cultures. Over time, individuals and societies may alter older patterns of behavior, adopt or create new traits, or pull back and detach from external influences (Social Science Research Council 1954). While cultures are constantly undergoing change, contact with external forces can increase the speed and alter the direction of change.

Some anthropologists have criticized the tendency within the discipline to perpetuate an isolated model of pristine foraging peoples (Eder 1988; Headland and Reid 1989). Whether any society is truly self-sufficient at the present time is debatable. Headland and Reid (1989) suggest a more appropriate approach to understanding foraging populations through an interdependent model in which different populations are linked through trade and exchange. A useful analytical approach involves looking at "various stages of culture change" (Headland and Reid 1989:44), which recognizes the wide variation in formation of indigenous foraging groups throughout history and today. Wolf (1972) approaches culture change as a process involving responses to economic and political forces acting on the acculturating group. More continuous and regular contact with individuals and institutions of different cultures exerts pressure to change existing institutions and behaviors. This can result in a pattern of decreasing autonomy and

increasing dependency on the dominant system, an economic and sociopolitical system in which the acculturating group has a marginal role. The disruptive process is occurring more rapidly than in the past because of shrinking geographical, economic, and social distances, necessitating in-depth research into possible outcomes.

Two important concepts for understanding the process of culture change are acculturation and integration. There are several ways of applying the often-overlapping concepts of acculturation and integration of small-scale societies. In general, we are referring to processes that are part of larger culture change. Acculturation refers more to broader social behaviors and customs, while integration is specific to participation and orientation of economic behavior.

Acculturation

Early definitions of acculturation come out of anthropology with the following classic definition provided by Redfield, Linton, and Herskovits (1936:149) as the

> phenomena which results when groups of individuals having different cultures come into continuous first-hand contact with subsequent changes in the original culture patterns of either or both groups.

The study of this concept was advanced significantly by researchers in cross-cultural psychology. In 1954, the Social Science Research Council (1954:974) offered a revised definition of acculturation as

> culture change that is initiated by the conjunction of two or more autonomous cultural systems. Its dynamics can be seen as the selective adaptation of value systems, the processes of integration and differentiation, the generation of developmental sequences, and the operation of role determinants and personality factors.

From these definitions, acculturation can be seen as a process through which behavior is influenced by outside cultures. Acculturation, which is distinct yet related to market integration, encompasses the adoption of features of an exogenous culture by the

acculturating group. Peterson (1991:6) defines acculturation as "increasing assimilation to the national culture and loss of cultural distinctiveness." Both of the classic definitions above imply the adoption and/or alteration of prior cultural features or values. Increased contact may exert pressure for change in the direction of cultural assimilation. By contrast, Wirsing (1985:305) defines "unacculturated" people as having the characteristics of geographic isolation, an unwritten language different from the national one, low levels of technology, and low economic specialization.

Acculturation should be conceptualized as multidimensional. It is a process that occurs over time and place. "Acculturation can be viewed as a multilinear phenomenon, as a set of alternatives, rather than a single dimension ending in absorption into a "modern society" (Berry et al.1986:305). Common measures of acculturation include proficiency in the national language, years of contact with the modern population, distance to the nearest trading town (Gross et al. 1979), level obtained in formal education, participation in national politics, social relations and interactions with members of dominant culture, religion (Berry et al. 1986), and value orientation (Dressler 1996). In measuring degrees of acculturation, not all measures are related (Trimble 2003). Berry et al. (1986) wrote "not everybody in the acculturating group will necessarily enter into the acculturation process in the same way or to the same degree" (1986:296). There are different stages and ways of engaging the dominant culture by the acculturating individual or group. Factors such as purpose, length, and permanence of contact are important to consider.

Economic Integration

Scholars often use integration synonymously with participation and involvement in the market economy or system of exchange. Market integration differs from

acculturation in that it refers specifically to articulation with a specific *economic* system, that is, the degree of involvement and dependency on the market for acquisition of subsistence needs. Compared with acculturation, economic integration is analyzed more through material measures of behavior. Still, an examination of the literature reveals an often-indiscriminate use of these two terms, complicating the interpretation of research findings.

When looking at indigenous groups in Amazonia who are undergoing rapid economic change, it is useful to make the distinction that such societies are not necessarily going through the process of *developing* markets, but rather *integrating* into an existing market system. A subsistence mode of production may shift toward a mode that facilitates or intentionally strives to extract surplus for commercial exchange. For example, small-scale agriculturalists or forest horticulturalists can expand crop production with the intention of exchange in the market for commercial goods and services, or to amass capital (Heilbroner 1985). They might reorient their economic strategy toward wealth accumulation.

In a comparative study of four ethnic groups in the Brazilian Amazon, Gross et al. (1979:1049) defined market integration and participation as "activities that result in the production of goods and services for exchange with non-Indians outside of the village community." This definition goes beyond the exchange or use of cash, to include the exchange specifically with people exogenous to the ethnicity. Gross et al. (1979) linked the degree of market participation with environmental and historical factors such as circumscription and encroachment of national frontiers and the process of becoming sedentary. The term "integrated" communicates the level of involvement in the wider

political economy, interrelation with other groups, and expanding socioeconomic networks (Johnson 1989:60). Integration into the market has been operationalized by the number of hours spent in market activities (Eder 1988; Gross et al. 1979; Henrich 1997), the proportion of subsistence derived from the market, indices of wealth assets (Henrich 1997), use of modern technology, distance from the village to a market town, number of government institutions in the village, use of credit (Godoy and Cardenas 2000), and the share of total income from market transactions.

Variation in Modes of Integration and Motivations

Tropical forest peoples have been involved in exchange relations with exogenous actors throughout history (Bird-David 1988; Eder 1988; Headland and Reid 1989; Reed 1995). In the last century, however, indigenous forager-horticultural groups have become increasingly economically and socially integrated into regional, national, and international systems. These shifts in economic orientation have been associated with religious missionization efforts (Helms 1972), contact with dominant societies (Murphy and Steward 1968), national colonization programs (Sponsel et al. 1996), frontier expansion (Putsche 2000; Ramos 1984; Sponsel et al. 1996), environmental degradation (Gross et al. 1979), development projects (Gray 1990; Santos et al. 1997), and new market opportunities (Murphy and Steward 1968). Contact with dominant cultures for South American tropical peoples has intensified in the last two decades. This "contact" with industrialized societies has been discussed as causing change or disruption in the adaptation of traditional groups (Wirsing 1985:303). Often there are certain qualities of the dominant group that can meet specific needs such a new technologies, medicine, and products (Berry et al. 1986). Scholars have identified market participation as an important force to transforming social structures (Gross et al. 1979). Likewise, changes

in economic institutions, how indigenous forest peoples organize production and consumption activities to meet material needs, also accompany market participation.

Indigenous peoples in tropical forests integrate into a market system through two primary modes: 1) sale and barter of forest products or the surplus of their subsistence production and 2) sale of their labor. Researchers studying the effects of market integration on indigenous societies have arrived at different conclusions. Different types of participation in the market need to be examined to understand the variation in consequences. For example, economic integration may include wage labor or the sale of either agricultural or forest products. The difference between commodity and labor integration might be significant (Godoy 2001). This variation makes it difficult to arrive at general theories about the effects of markets on welfare (Eder 1988; Godoy 2001).

Different circumstances lead to the participation or intensification of market activities in tropical ecologies. Integration has neither a common commencement nor is a universal process. Understanding motivations for participation has implications for whether scholars see the market as an institution that erodes traditional organization, provides a substitute or safety net or social insurance, or as an opportunity to actively expand one's productive and consumption base. There are both proximate and ultimate causes of integration into the market system (Putsche 2000; Sponsel et al. 1996). Godoy (2001) summarizes three approaches to explain why people become more market integrated: natural processes, pressure from encroachment bodies, and conscious choice. Gross et al. (1979) offered a hypothesis of market participation based on difficulty of procuring subsistence through traditional means. Similar to Eder (1988), Gross and colleagues saw that market involvement was related to the difficulty in meeting

subsistence needs through traditional productive activities (Gross et al. 1979). As constraints to meeting subsistence needs increase, intensification and use of technology follows with a resulting dependency on market derived tools and other goods. There is also variation in how villages, households, and individuals articulate with a market economy. Some actors/households/communities are better positioned to take advantage of market opportunities while others turn to the market economy as a last alternative in an eroding subsistence livelihood.

In studying how changing economic orientations affect social systems our research team found that, even within the same village, some households or individuals will become involved while others will not. Both individual and household data are necessary to account for possible variation in participation. Godoy (2001) conceives of a choice to participate in markets and individual inclinations (fixed effects) to become more acculturated. Henrich (1997) also acknowledges individual agency in his study of the Machiguenga in Peru. He claims that the Machiguenga people are not compelled into market activity by structural forces, as is argued in most studies, but rather they are actively interested in integrating.

Definitions of acculturation and integration often imply an underlying lack of agency by members of native cultures. However, the impact of integration and acculturation is not unidirectional. How native individuals and groups relate to these forces varies. There may be elements of the new culture that are attractive and sought after such as technologies and commodities. The participation of forager-horticulturalists in the market system changes the system itself. With integration into the market economy, there is an expansion of roles as consumers, sellers, and innovators of new

products. As buyers they create new and/or expanded demand for specific market-traded items. As sellers, they introduce competition with traders and merchants of the similar products. Whether or not dependency is an inevitable outcome of market participation varies by who is controlling and determining relationships with the market (Gray 1990). Research suggests that when indigenous people do not control their own marketing, integration to the market will be detrimental to their social and economic livelihoods (Gray 1990). Richards (1997) offers a situation where there might occur a positive response to the increased demand in market process. When the commodity whose production is intensified during economic integration is of cultural or historical significance to the indigenous group, there might be a reinforcement of indigenous values (Richards 1997). Unfortunately, in Amazonia, the activities through which native people historically articulate with the market economy, such as rubber tapping, logging, and oil exploration, have not been compatible with native social and economic institutions.

Changes in Traditional Social and Economic Institutions

The processes of market integration and acculturation indirectly impact health through the modification of social and economic institutions. This section examines the changes in social and economic organization that come from the incorporation and adoption of a cash economy. First, I describe the link between market integration and social and economic institutions. Next, I complete the connection by looking at how these changed institutions influence health.

Several authors have proposed that markets erode traditional social insurance institutions (Lee 1988; Murphy and Steward 1968). Reciprocal sharing of food, as mentioned earlier, is a strategy for mediating risk and uncertainty inherent in tropical forests. Through economic integration, the market system allegedly replaces this

traditional institution. When there is no longer a need to share, or as a substitute for this safety net arises, generalized reciprocity declines or ceases to occur. Putsche (2000) found that purchased items were shared less than home procured items. This has implications for periods of vulnerability associated with seasonal availability of food resources as well as shocks such as prolonged illness episodes or death. Lee (1988) argued that the spread of capitalism has destroyed the communal base of many societies. Murphy and Steward's (1968) classic comparative study of Montagnais in Canada and Mundurucú in Brazil highlights how market integration and acculturation culminated in social deterioration.

There is also evidence that market integration does not erode social institutions in all cases. The Mbuti of the Ituri Forest in Central Africa have a history of exchange relations and resistance to dominance. They have been commercially active through bushmeat trade without disrupting social priorities and communal hunting practices (Hart 1978). However, Hart found that Mbuti meat consumption was promised to meat trader demands during poor hunting returns. Reed (1995) similarly concluded that among the Guaraní of Paraguay, market participation did not erode reciprocal institutions and networks because they maintained a base in subsistence production and integrated market commodities into traditional systems of exchange.

The degree to which the sharing ethos of a particular group is maintained, modified, or disregarded when faced with increased integration varies. Intragroup dependencies may not be immediately eroded, as in the Guaraní case, but the situation might eventually erode more with increased dependency on and relations with exogenous trading partners. Eventually tropical peoples have been observed to relinquish hunting

and gathering activities, reorienting more toward the market for acquisition of food and other commercial goods. The different stages of the process of integration may explain the difference in research findings on the impact of market participation.

The use of money as medium of exchange can be contrasted with a barter-based exchange system. The introduction of money alters the relations of exchange in fundamental ways through the establishment of a foreign standard unit of value. Increasingly, there becomes a need for cash to enact exchanges for subsistence needs. Behrens (1992) found that cash transactions decreased participation in traditional kin-based exchange networks and lessened the importance of women in forming and maintaining networks. Reciprocity may still be important where there are poorly developed credit markets (Godoy 2001). Godoy questions whether markets weaken reciprocity, and if weakened reciprocity in fact creates a vulnerable situation for indigenous people.

Social norms, such as proscriptions against internal sale of commodities among subsistence-level groups, break down with increased market activity. With agricultural intensification oriented toward cash crops, households become nucleated, seek the cash market for labor, and often participate in intravillage sale rather than reciprocal exchange of food (Behrens 1992). With the advent of cash cropping, there is less redistribution of subsistence products. Cash becomes a commodity that is not shared among others or loaned with great ease.

When social and economic institutions meet material needs come under pressures to change, there is a risk to the welfare of the people. If the ability to produce or procure food energy is compromised, there will be health consequences for individuals in the

group. The ecological balance of societies that acquire a large proportion of their food from the natural environment is threatened when the population density increases as a result of market integration.

Linking Health and Markets

Many Amazonian groups are facing increasing ecological and social pressures brought on by accelerating contact with national market systems. The relationship among economic integration, acculturation, and the health of subsistence-level populations is still unclear. In my research, I attempt to clarify these relationships. Illness prevalence, dietary intake, and nutritional status are indicators of overall health status, an aspect of human welfare which is vulnerable to the changes I have described in the preceding section. In this section, I explore the direct effects of market integration and altered social and economic institutions on health. Each area is discussed in greater detail in the corresponding analytical chapter. Figure 1-1 shows how the processes of integration and acculturation act on one another during the process of culture change; and alludes to some of the possible impacts on health that I explore in this dissertation.

Self-Perceived Health Status

Contact with members of an exogenous group allows for exposure to new pathogens. More importantly, the disruption of traditional subsistence patterns as a result of territorial encroachment and market expansion can limit indigenous peoples' capacity to maintain their own health and well-being. Two interrelated components of human welfare affected by these pressures are health status and health-seeking behaviors. With greater contact and integration through economic exchange, use of medical services, and formal education, the manner by which individuals experience illness and use treatment modalities and societal modes of recognizing and treating diseases are altered.

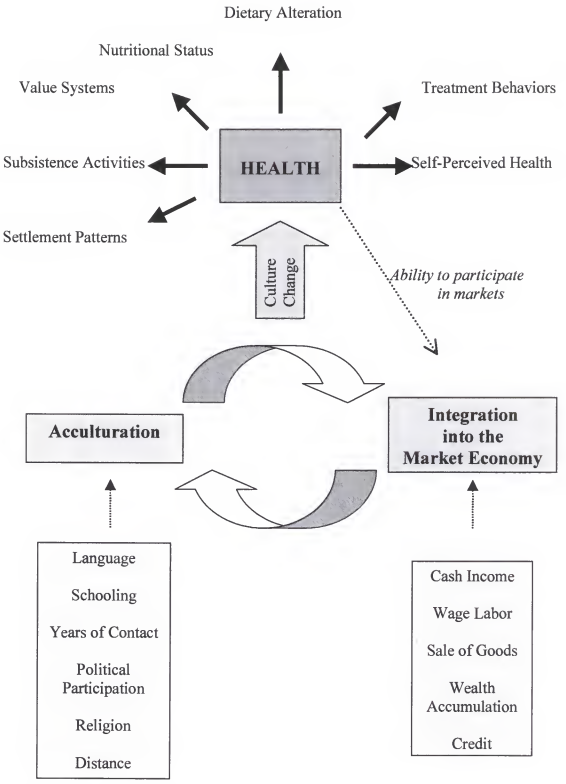

Figure 1-1. Relationships between market integration, acculturation, and health

The nature of the relationship between markets and health is unclear because of the myriad factors that mediate both economic participation and health. From one perspective, market integration may improve objective morbidity yet increase self-perceived morbidity (Godoy and Cardenas 2000). Godoy and Cardenas (2000) hypothesized that with greater integration into the market economy, people get sick less, yet have a lower threshold for illness. This lower threshold is tied to their higher expectations for their health (Goodland 1988) and greater identification or labeling of illnesses as observed through more frequent reporting of minor ailments. As people become acculturated to a different understanding of what it means to be healthy, their standards of hygiene and perceptions of good health undergo revision. Self-reports of illness capture perceptions of physical and emotional states relative to an understood standard. To be sick translates into not meeting the acceptable characteristics of good health, which often differ from one culture to another. Increased contact and familiarity with health-care services may actually heighten perceptions of morbidity (Murray and Chen 1992). Self-reported illness has been found to be positively related to income (Murray et al. 1992; Murray and Chen 1992), but it is necessary to tease out whether the relationship is caused by objective changes in morbidity. Alternatively, participation in the market system could allow individuals to take time off from labor activities when ill, while subsistence-based activities cannot go similarly unattended, depending on one's social capital. Still, income opportunities lost due to time spent seeking treatment are trade-offs that individuals and households face.

Greater economic opportunities that accompany market expansion may facilitate access to medical services, better nutritional status, and improved education and

knowledge about illness prevention. These benefits, of course, depend on whether individuals and households actually avail themselves of these services and information. Access is not just an economic constraint, but also a social constraint. Receiving the benefits of modern medical services such as vaccinations, surgical care, and pharmaceuticals hinges on important factors such as language use, communication skills, gender, class and racial barriers, trust, and familiarity with a health care system. New health knowledge available only in the dominant language will not evenly reach the members of the acculturating group.

Utilization of health services is another measure of self-perceived morbidity. Rather than measuring perceptions of illness, this measure conveys information about perceived efficacy of treatments, access to health care of different types, and price factors (both monetary and in time) (Murray and Chen 1992). Greater integration into the market system might be associated with wider availability of medical services from which to pick. Use of traditional medicines and treatments may also indicate changes in health status or ability to access other services.

The relationship between access to and use of medical services is complex. Utilization of health services is a result of many factors including access, availability, severity, perceived efficacy, and cost (Murray et al. 1992). As part of integration and acculturation, people come into contact with a range of new options for managing illness and disease. Whether or not this influences their treatment behaviors is important to understand. Both access and perceived need factor into decisions about what type of treatment to seek.

Markets and Dietary Health

Dietary alteration and changes in nutritional status resulting from economic integration or acculturating forces has been studied in many places. The manner in which populations are brought into contact with market systems is significant to the analysis of their nutritional status. Studies have looked at forced human resettlement (Wilkie 1989), ecological constraints (Carneiro 1974; Shell-Duncan and Obiero 2000), willing participation (Henrich 1997), and colonization schemes (Ventura Santos and Coimbra 1996).

Brown and Konner (1998) argue that most humans have lived without a predictable food source, evolving in environments prone to food shortage. Cohen (1989) writes that changes in human diet and nutritional status have accompanied change in economic modes of subsistence over time. As groups shift from a mode of production based on hunting and gathering to small-scale horticulture, and onto commodity agriculture there are associated changes in their diet. Archeological evidence has also been uncovered linking differences in nutritional health of hunter-gatherers and agriculturalists to their mode of production (Armelagos 1990; Cassidy 1980; Larson 1995).

As foraging groups shift subsistence practices toward the cultivation of food, qualitative and quantitative changes occur in their diet. The composition of food resources is altered with the domestication of plants and animals. There are also notable differences in diet breadth between sedentary and migratory populations. The analysis of changes in availability and distribution of food resources over the last 250 years emphasizes a pattern of delocalization of production and distribution (Pelto and Pelto 2000). An ever-increasing proportion of the diet comes from sources outside of the immediate community.

Seasonal fluctuation in food availability can be affected by market participation as well. Increased integration into national economic systems of exchange and acculturation can have the potential benefit of greater access to income and thus purchased foods (Dennett and Connell 1988; Holmes 1985). These market foods can serve as buffers against seasonal fluctuations. In theory, access to markets should provide an opportunity for a more predictable stable food source capable of withstanding seasonal fluctuations and nutritional vulnerability experienced by forager-horticulturalists. In practice however, the mode by which individuals and households become articulated into the market system is complex. The existence of market-traded food sources does not guarantee access to these items, particularly for populations originating in exchange-based economies rather than the capitalist model of commodity exchange. Too often access is an assumed rather than demonstrated component of integration to the market economy and serves as a foundation for an argument in favor of health benefits to transitioning populations.

Dietary practices may be modified via acculturation or competition for resources (Berlin 1985). Prestige and status associated with different foods may counter any benefit of expanded education about food choices. Shifts in food taboos or avoidances can be affected by acculturation, essentially redefining what constitutes food resources (Aunger 1996; Berlin 1985).

Nutritional Consequences

Human nutritional status is also particularly sensitive to economic and cultural change. Increasing contact with and participation in market economies can bring both costs and benefits to the nutritional health of the acculturating group. Research on

economic and nutritional transition among populations in tropical forests and other ecological regions has turned up different findings.

There is evidence that integration into the market economy does not lead to improvements in nutritional status. The dependency on market-derived foods that may have a lower nutritional value than home produced items can be detrimental to nutritional status (Dewey 1981). As households intensify agricultural production for sale in the market, there may be a decline in both quality and quantity of household consumption. Follér (1995) writes that indigenous peoples are not experiencing the benefits of integration with respect to health. The marginal status that they occupy is an obstacle to accessing potential market benefits, and risks such as diseases associated with consumption of processed foods and loss of micronutrients are increased.

Other scholars such as Rebecca Holmes (1985) have challenged this assumption that traditional villages have better health, measured through nutritional status, than more "civilized" populations. She concluded that culture change did not lead to poorer nutritional status, but rather her findings pointed toward the access and utilization of medical services and community stability as correlates of good health (Holmes 1985). With increased acculturation, the inclusion of purchased food in the diet and introduction of exogenous diseases may be offset by access to modern medical and dental treatment.

Still others acknowledge that the market effect is not uniform (Dennett and Connell 1988; Leonard and Thomas 1988). It is my intention with this dissertation to examine the factors of market integration and acculturation through which health effects are mediated. With my data from the Tsimane' in Bolivia, I address the different levels of involvement

in the market economy and measures of acculturation to compare the relationship to several measures of health.

The Tsimane': A Case Study of Market Integration

Understanding how increased participation in a market economy affects the health of tropical forest peoples requires approaching integration as a process rather than a single event. Studies that analyze the effects of market integration need to approach it as iterative changes, rather than as a switch from some metaphorical traditional mode, persistent until the time of study to a sudden catapult into a market integrating phase. The process from a traditional subsistence mode to a market-influenced mode of livelihood requires more attention. The relationship between markets and health are best studied through a longitudinal research design. Comparison of groups living under similar socioeconomic and ecological conditions is useful to better understand how changes associated with economic integration affect social and economic organization. Even so, it is still debated as to whether market integration is a beneficial or detrimental process for the health of indigenous societies (Godoy 2001; Richards 1997). This may, in part, be attributed to the differences in operationalizing integration and acculturation.

Based on the literature on the relationship between markets and health I developed research objectives and seven hypotheses to test whether, in fact, markets do positively affect different dimensions of the health of indigenous peoples in the tropics. I present and test each hypothesis in this dissertation using data from 18 months of intensive study of Tsimane' Amerindians of lowland Bolivia. I studied their economic behavior, health status, dietary intake, and nutritional status. The Tsimane' are a suitable population among which to study relationships between health and integration and acculturation as they are currently undergoing varying degrees of market integration. The variation both

within and between communities provides a good example for comparing the effect of acculturation and integration into the market economy on various aspects of health.

My research among the Tsimane' contributes to the ongoing debate about the effects of market integration on health. Vague and inconsistent conclusions about these relationships are in part are due to the fact that different forms of integration may affect health differently. However, markets may not have any directly generalizable impact on the health and welfare of indigenous forest peoples. The effects may be mediated through degree and type of integration. Any effect may be an artifact of how variables are defined to measure market integration and acculturation. To address this issue, I disaggregate the different activities through which indigenous peoples participate in the market system so as to be able to test both type and degree of integration and acculturation. In the next chapter, I explain the methods used to operationalize and measure market integration, acculturation, and health.

CHAPTER 2
METHODS

Introduction

In this chapter I describe the research design and methods used to collect data for the analysis of the relationships among acculturation, integration to the market economy, health, and nutrition. The methods chosen for this research design reflect a variety of considerations including: research objectives, plans for data analysis, facility in applying the methods accurately in a tropical setting, cultural appropriateness, cost, and human resource requirements. Each of the methods is presented with a discussion of the advantages and limitations along with the justification in selecting the methods for this study. There are many different approaches to examining issues of indigenous health and economic integration that draw on either qualitative or quantitative methods of data collection. A systematic and quantitative approach to measuring market integration, acculturation and indicators of health was adopted in order to define and test hypotheses about the relationships between integration and health.

Data presented in this dissertation represent the health and nutritional component of a larger study of the effects of integration into the market on the use of natural resources conducted by an international and interdisciplinary research team of which I was a member.[1] Together, our research team was interested in the relationships among

[1] The larger study, "The Impact of Market Integration on Health, Knowledge, and Resource Use among the Tsimane' of Beni, Bolivia," was directed by anthropologists Ricardo Godoy and William R. Leonard, and conservation biologist David Wilkie, and funded by National Science Foundation (SBR-9417570), MacArthur Foundation, and Food, Health, and Conservation grants to the principal investigators. A NSF

integration into the market and various social and biological phenomena. Therefore, the research design for measuring market integration was developed through a team and multidisciplinary approach and all members utilized the data in doctoral dissertations, undergraduate theses, and professional publications. Each member was responsible for developing the survey instruments specific to their research interests. I was responsible for the research design that included the health, dietary, and nutritional components.

Team Approach

Our interdisciplinary team of researchers collected the panel data in the Beni department of Bolivia over 18 months between May 1999 and November 2000. The field team was composed of two anthropology graduate students from the University of Florida (Victoria Reyes-García and myself) and two biology undergraduate students from the Universidad Mayor de San Andrés in La Paz (Lilian Apaza and Eddy Pérez). We divided into two sets of an anthropologist and biologist to reside in the villages of San Antonio (Apaza and myself) and Yaranda (Reyes-García and Pérez). An independent agronomist (Vincent Vadez) joined the team in Yaranda during Quarter 2 of the panel research and continued until the end of the study. Anthropologists are beginning to acknowledge limits to data collection such as the inability to collect data in different locations simultaneously when they work alone in the field (Henrich 1997). Our team approach allowed for a multi-site research design for data collection.

In each site, team members administered the same survey instruments on a three-month or "quarterly" schedule. The quarterly research schedule was composed of a series of four different survey modules: 1) economic activity, 2) consumption, 3) illness

Research Experience for Graduates (REG) grant provided supplemental funds for my return visit in June of 2001.

and diet, and 4) nutrition. Each quarter the two sets of researchers began by collecting economic measures in their respective communities. Once complete, we moved onto the other modules in the above sequence. This sequence was designed to satisfy time order requirements for statistical analysis. With measures of market integration and acculturation as the independent variables, they must necessarily be measured before the dependent measures of health status. Each of the instruments used to collect the different types of data relevant to the health study is described within this chapter. The two sets of researchers worked on the calendar of scheduled data collection to ensure that similar data were collected within a comparable time frame.

Site Selection and Sampling Strategy

To explore the influence of market integration on physical health, dietary intake, and nutritional status, our research team collected data in two ways: 1) an in-depth 15-month panel sample frame in two Tsimane' communities, and 2) a cross-section of 58 communities with different levels of exposure to a market system. For this dissertation, I test my specific research hypotheses on only the panel data set.

Site Selection

Site selection for the study was informed by past experiences working in the region with the Tsimane' people (Godoy 2001; Godoy and Cardenas 2000; Godoy et al. 1997) and a preliminary field visit by Godoy and Wilkie. They identified two ecologically comparable Tsimane' communities through visits and meetings with the Gran Consejo Tsimane', the political authority representing the Tsimane' ethnic group. In determining the final research sites they considered comparability, variance in market integration, and the willingness of community residents to have a team of researchers take up residence for a year and a half. The principal investigators received formal permission to work in

the two selected communities of San Antonio and Yaranda from the Gran Consejo Tsimane' in the spring of 1999. At that time, the Gran Consejo Tsimane' also agreed to allow our team to conduct a larger cross-section study in additional Tsimane' communities the following year. Table 2-1 shows the calendar of field activities for the entire research project.

Table 2-1. Calendar of field work activities

Dates	Quarter	Research Activity			
May 10-Aug. 9 1999	0	Preliminary Research & Pilot Testing			
Aug. 10-Nov. 9 1999	1	Panel Study			
Nov. 10-Feb. 9 1999- 2000	2	Panel Study			
Feb. 10-May 9 2000	3	Panel Study			
May 10-Aug. 9 2000	4	Panel Study	Training for Cross-Section Study	Cross-Section Study	
Aug. 10-Nov. 9 2000	5	Panel Study		Cross-Section Study	
June 2001	~ 6				Follow-Up Visit

The two communities included in the sample represent different levels of economic integration and socio-cultural acculturation based on distance from the regional market town of San Borja, access to modern medical services, wages labor opportunities, and contact with the dominant national culture. Both communities are located along the Maniqui River in the Beni department. There are considerable differences in proximity to the regional market town of San Borja as well as exposure to acculturative influences.

San Antonio

The community of San Antonio is situated on the lower Maniqui River, 10 km to the northeast of the town of San Borja.[2] Thirty households are scattered along both banks of the river for a length of approximately 2.5 km. Each household has direct access to the river within 20 meters or so from their residence. Residents clear plots in close proximity to their houses. One side of the community (western bank) pushes up against savanna lands used for cattle ranching and is under greater land pressure than the more populated side (eastern bank) which boarders secondary forest. San Antonio is delimited downriver to the northeast by the Tsimane' community of Campo Bello (30 minutes by foot) located within the limits of the Estación Biológica del Beni (EBB) and the mestizo[3] community of Santa Elena upriver to the south (20 minutes by foot).

Yaranda

Yaranda is nestled back from the southeastern bank of the upper Maniqui River, 47 km from San Borja. Residents of the 24 households live within five to ten minutes by foot to the river's edge. This configuration reflects a conscious decision by residents to move their houses closer to a central area around the schoolhouse more than two decades ago. Yaranda is bordered by two other Tsimane' communities, Santa Maria and Cachuela, roughly two hours walking distance. Unlike San Antonio where fields are close to or surround the residential structures, the agricultural fields are farther away from the residences due to Yaranda's community layout. The clustered layout of Yaranda's households dictates frequent interactions as community members must pass around or

[2] Distances were measured by GPS representing linear distance from the town center, not actual road distance.

[3] People of mixed European and Native American ancestry.

through other residences in order to reach the river, their fields, or the forest. In San Antonio, the linear layout precludes any need to pass through neighboring households on a regular basis to reach one's field, the river, or the forest. Yaranda is more distant from San Borja and is overall less integrated into the regional market system. Yaranda is, however, integrated through the *jatata*[4] (*Genoma deversa*) palm trade between Tsimane' and itinerant river traders (discussed later in detail).

Panel Study Sample Design

A longitudinal or panel study consists of repeated observations on the same person (Deaton 1997). The cohort of individuals is referred to as the panel. Because nutritional and health status are directly affected by seasonal consumption patterns and resource availability, collecting data during different points in the annual cycle captures a wider range of circumstances than with only a one-time cross-section design. Collecting panel data also reduces error in the collection of data on household and individual income, key factors to this analysis. In cross-sectional study designs, income is typically measured at one point in time. A single measure excludes data necessary to analyze the seasonal variation in resources available (Benzeval and Judge 2001). For this reason, our team studied participants every three months (quarterly) over a fifteen-month period for a total of five observations per indicator. By doing this, our data capture information over more than a full annual productive cycle.

Definitions, Sample Size, and Attrition

Individuals 15 years or older were classified as *adults* as they are active economic producers through trade, sale, and agriculture by this age. Economic information was

[4] Throughout this dissertation words designated by italics indicate Spanish origin. Words designated by underlining indicate a Tsimane' term.

collected only from adults. Individuals younger than 15 years were treated as *children* in the sample. An adult living in the household, typically the mother, provided the information on the children during the various surveys. Individuals, both adults and children, are therefore the units of analysis. The total panel sample of two communities includes 150 adults and 182 children (n = 332).

One of the challenges inherent in a longitudinal sample design is attrition of subjects or households from the panel (Deaton 1997). Attrition can result from the dissolution or formation of households, death, migration, or refusal to remain in the study. Absenteeism due to extended visits to relatives in other communities, or wage-labor migration resulted in fluctuations in the sample size or the panel and therefore the dataset does not include complete data or observations on every individual in the panel for all five quarters. Likewise, new households were formed through marriage, births, or migration to the study community, or by shifts of individuals to new households within the same community. Despite these changes, the minimum number of subjects (n = 276 in Quarter 1) in the sample during any one quarter was still 83% of the maximum sample size (n = 332). The dataset contains records of all of these changes and they are accounted for in the pairing of measurements with individual and household-level variables. Table 2-2 reflects the sample of individuals captured in each of the five quarters.

Individuals in the sample were part of households in each of the communities. Our team defined *households* as a group of people sharing in production and consumption. We relied on Tsimane' definitions of who was and who was not a member of the household. Households were typically composed of the individuals who lived in close

proximity, cooked on the same hearth, and shared in food resources. Generally, this included a nuclear family with perhaps a young married son or daughter and their recent spouse. In San Antonio, we found more nuclear families than in Yaranda where households were more often organized through larger extended kin ties.

Table 2-2. Sample size by quarter

Quarter	Women	Men	Girls	Boys	Total
1	63	67	66	80	276
2	67	71	73	85	296
3	67	72	73	79	291
4	67	65	73	81	286
5	70	69	80	88	307

Preliminary Research and Pilot Testing

Preliminary Research

The U.S. based researchers (Godoy, Reyes-García, and myself) developed the preliminary survey instruments before departure to Bolivia. During weekly meetings with Godoy in the spring of 1999 at the University of Florida, we discussed hypotheses and generated relevant survey instruments for data collection in the field. Once in Bolivia, our entire team further tailored these instruments to the Tsimane' culture. We conducted preliminary research and pilot testing from May to August 1999 to identify a sample of households to study, find out what traditional and modern health resources were available, and learn about Tsimane' definitions of illness and health. We met with community leaders and households in a general meeting and followed up by visiting each potential study household to explain our team's intentions and research focus. In San Antonio, three households on the far edge of the community refused to participate in the study, and in Yaranda only two households declined. We respected their preferences and

did not collect data in those households. Therefore, the final sample for the panel study included 51 households (San Antonio = 27; Yaranda = 24) in the two villages agreeing to participate in the study. This translates into 189 individuals in San Antonio and 143 in Yaranda.

One of the goals of this pilot phase was to compile a complete list of potential responses and codes for the closed ended-portions of the surveys to facilitate coding and data entry. The methods to accomplish these goals are based in large part on rapid rural assessments of primary health care (Scrimshaw and Hurtado 1987), participant observation, and semi-structured interviews with residents and health providers. With the help of Alonzo Nate, a Tsimane' translator and guide, we generated plant, animal, market product, and illness lists and translated portions of the different modules directly into the Tsimane' language. During initial visits to both communities, I informally elicited lists of illnesses known to the Tsimane' in both Spanish and Tsimane' and eventually established trilingual (Tsimane', Spanish, and English) databases of response codes.

Language Training

During these initial months our team further devoted time to language study and training in data collection with the help of Nate and existing grammars developed by evangelical missionaries (Gill and Gill 1988; Gill and Gill n.d.; Mayer Roca and Caymani 1999). While some Tsimane' are bilingual in Tsimane' and Spanish (24% of the adults in panel sample; 12% of adults in the cross-section), it was necessary to conduct interviews in their native language to reach the full range of study participants, especially women who are more often monolingual in Tsimane'. We employed bilingual Tsimane' men as translators in the preparation of the instruments and to assist in the interview process through the oral translation of questions and responses. Alonzo Nate

accompanied the team members who lived and worked in Yaranda (Reyes-García and Pérez) and Jorge Cuatta and Pablino Pache worked as the principal translators in their home community of San Antonio with the other members (Apaza and Byron). We studied the basics of the Tsimane' language in order to ask questions and eventually achieved a functional conversational level. Owing to the repetitive nature of the survey schedule and high frequency of quantitative responses, our competency level in the Tsimane' language was sufficient for understanding the majority of the responses. Nevertheless, the role of our translators in facilitating the logistical and substantive support was invaluable.

Pilot Testing

In mid-June 1999, our team visited San Antonio to pilot test the different modules. We chose San Antonio for the pilot testing because of the greater logistical ease of movement back and forth between the community and San Borja where we were conducting our fieldwork preparations. Each researcher took the initiative to explain her or his research component and instruct the other team members on survey delivery, as we would rely on two sets of researchers to collect data on a parallel schedule. As the quarterly research schedule spans across three months, we needed to test all the modules without burdening the participants. We divided the team and selected several households to test and refine each method. Three undergraduate anthropology students from the University of Florida, Julian Castañeda, Michelle Lieberman, and Luke Williams, accompanied our team and assisted in the pilot-testing phase. Leonard came from Northwestern University to train our team in anthropometric measurement and practice on families in San Antonio.

In addition to refining the research instruments, our team aimed to ensure that our ideas based on training in anthropological and biological theory and method would be culturally appropriate and acceptable to the Tsimane' participants. For example, we anticipated that the body measurements or income surveys might pose obstacles to successful completion. In the field we found that the Tsimane' do not mind talking about their income and generally, the body measurements were culturally appropriate. With the exception of a few households in Yaranda where there seemed to be more reluctance to the measurements by some small children, participants enjoyed the anthropometric segment of the research as it was organized into a quasi-social event and gathering.

Data Entry and Storage

The two sets of researchers entered the majority of the data from their respective communities while in the field using portable computers powered by solar panels affixed to the roofs of our houses. We entered the data into Microsoft Access at quarterly intervals. Throughout the research period, our team met periodically in San Borja to discuss methodological issues. Each team member visited the other community with a specific focus on her or his topics, for short periods of time to acquire a sufficient understanding of life in both communities. Upon return to the United States, Godoy, Reyes-García, and myself merged and cleaned the data set in STATA 7.

Survey Modules

Baseline Surveys

Socio-demographic information

In the initial three-month phase of panel research (May–August 1999), our team collected baseline demographic information on all individuals in the households interested in participating in the panel study. This baseline included the measures of

acculturation to be used as explanatory variables. Demographic information included names of household members, ages, birth dates, educational histories, residency, religion, and literacy scores on language (both Tsimane' and Spanish), and numerical competency tests for all individuals in the household. Educational attainment for the mothers and fathers of all individuals was elicited to find out whether each parent was literate or had attended any formal schooling. We also asked participants about their frequency of visits to the market town, provincial capital and national capital. Throughout the study, we recorded any births, new additions to household, or deaths and updated the demographic database accordingly. In any panel sample design there exists the risk of participants dropping out of the study for a numerous reasons. For this reason, we also recorded the attrition of individuals or households from the panel sample and the reason behind their removal.

Problems with aging the population

An essential variable in the baseline survey was the subject's age or birth date since many of the Western reference measures of health used in this analysis are age-dependent. However, there are rarely any written records of births in Tsimane' communities. Establishing ages for adults was difficult particularly in the more isolated community of Yaranda. While some individuals associate their birth dates with particular festivals or other seasonally significant periods, they often are unable to narrow down in which calendar month that festival falls. This methodological complication has been noted by some researchers (Coimbra et al. 2002; Hern 1994), yet is often overlooked. To cope with this challenge, we adjusted ages provided by parents throughout the year. Information elicited from reproductive histories, school records, and

comparisons with neighbors and other relatives helped us piece together more accurate estimates of ages and birth dates.

A small percentage of Tsimane' adults have Bolivian identification cards or *carnets,* but we later found out that the ages and birth dates inscribed on these cards were haphazardly assigned. One of the most highly educated Tsimane' proudly recounted his experience working on the identification card campaign; part of his responsibility was to "assign" ages to the participants according to his own judgment. This problem of aging the population is a major obstacle to the analysis of the data on children and might be one reason explaining the dearth of information on health status for these types of populations. Nevertheless, age is not without error and this must be taken into account in any analysis, particularly the age-dependent interpretations of anthropometric indices. Other authors have remarked on this similar difficulty in establishing accurate ages and the implications for interpreting measures of nutritional status (Keller 1991; Shell-Duncan and Obungu Obiero 2000). These limitations will be discussed in further detail during the presentation and discussion of the nutritional status data in Chapter 8.

Reproductive histories

To better understand lifetime fertility, infant mortality, and birth spacing, I assembled reproductive histories for all women past menarche and with a male partner or husband. Working with either a female or male translator, I met with each of the women in both San Antonio and Yaranda to record information on their total number of pregnancies, the outcome of each pregnancy, and present status of the child. The instrument was based on modifications from Weiner and Lourie (1969). Tsimane' women were comfortable discussing the pregnancies even when a pregnancy had been terminated by abortion or miscarriage. Often an adult child would assist in putting the

woman's children in accurate sequential order and spacing during the interview. This aided somewhat in establishing ages.

Panel research design

The panel research design is composed of four modules or segments, organized in a specific sequence within each quarterly round of data collection according to our research hypotheses. Each of the survey modules relevant to the analysis of health and markets and its corresponding subsections are described in this section and depicted in Table 2-3. I also discuss relevant methodological limitations and challenges to each subsection.

Table 2-3. Panel study design quarterly (3 month/12 week) research schedule

Module	Surveys	Approximate Schedule
Module 1	*Economic Activity over last 30 days* Cash and In-kind Income Survey Credit Survey Wealth Survey Village-Level Prices	Weeks 1-3
Module 2	*Daily Consumption* Weigh Days	Weeks 4-6
Module 3	*Health and Diet* 7-day Self-Perceived Illness Survey 24-hour Dietary Recall Surveys	Weeks 6-7
Module 4	*Nutritional Status* Anthropometric Measurements	Weeks 8-9
	Data Entry & Researcher Vacation	Weeks 10-12

Module 1: Economic Activity over the Last 30 Days

This first module captured measures of integration and activity in the market economy. The economic component incorporated three different surveys for eliciting data at the individual-level: a) cash and in-kind income, b) credit, c) wealth, and d) a one

village-level survey on price information. We surveyed all adults to recall their individual economic activity and wealth of material assets over the past 30 days.

Collecting data from a specific temporal segment can be problematic in a population that uses more generalized categories of time than the researcher's. One of the methodological issues associated with this recall error is "telescoping" or the tendency to look farther back in time than the reference point (Sudman and Bradburn (1974) discussed in Bernard 1995:235). We attempted to mediate this potential problem by providing temporal reference cues. Often prompts of porojma, (long ago), were made by the translators to help decide if the economic transaction occurred within or beyond the timeframe for the survey. When possible, reference events were suggested to enhance accuracy of recall (Loftus and Marburger 1983). Our team's full-time residence in the two communities aided in this recall because we actively participated in or were knowledgeable of local events. Community festivals, national holidays, visits from vaccination brigades, or the research team's return from vacation, are examples we frequently used to set the temporal reference for a prior month's period.

Cash and in-kind income survey

Individual-level income is one of the principal measures of integration into the market economy in this study. Type of income, cash or in-kind, may factor differently into the overall welfare of individuals and their households. Therefore, we recorded individual-level income earned within the past 30 days disaggregated by type of income, either in cash or in-kind. Although more time consuming, the rigor of collecting economic data disaggregated to the individual-level allowed us to aggregate data up to the household or village-level at a later time. Many researchers report household income based on methods of recording income only from an adult male. The significance of

individual-level and gender-disaggregated economic data has been an important contribution of anthropological research methods coming out of gender and development studies (Massiah 1981; Safilios-Rothschild 1984). Income was further disaggregated by source of income as either sale of goods, wage labor, barter, or gift/remittance to be used in an analysis on whether the source of income affects health in different ways.

The income survey began by asking each adult what she or he had traded or sold in the last month, prompting with inquiries about any visits to the market town or contact with traders. We probed for products specific to each season (Bernard 1995). It was helpful to ask about categories of items (e.g., plantains, rice, maize, or manioc), and then ask the volume of what they sold (e.g., kilograms, units, bunches). Next, we inquired about the unit price in order to calculate the total income from sale or value of exchange. With large sales, the total income was often provided rather than the total quantity of sale items. Monetary values were assigned to the in-kind trades according to the value of the item received as payment.

The distance from the market town poses several challenges to assigning economic values to goods bartered farther upriver (Wollenberg and Septiani Nawir 1998). In Yaranda, the price of the *jatata* thatch panels, the functional currency on the upper Maniqui River, was used to calculate monetary value. Generally, a value of one peso Boliviano (Bs.) per panel was assigned to the exchange calculations.[5]

For income from wage labor, both the specific labor activity and the daily wage earned were recorded. Labor paid in cash was directly recorded as the value received by the wage earner. Even though males frequently work temporarily on cattle ranches, with

[5] During the 18 months 6 Bs. ≈ U.S. $1.

loggers and traders, or in San Borja, there are no regular remittances from these forms of labor migration. Upon return, males might bring back cash or products purchased from wages, but it was uncommon for remittances to be sent or couriered back to the communities while away.

Our team had to account for one specific type of gift income in this survey. The larger study incorporated a time preference game in which participants received small sums of cash and candy through either immediate or delayed reward schedules. Income generated directly from our study was included in monthly income but coded so its effect could be measured.

Credit survey

As mentioned in Chapter 1, well-functioning credit markets have been shown to influence an individual's or household's ability to maintain health and access services (Morduch 1995). In our research design, we saw credit as potentially influential to health and welfare. We recorded the amount, source, and reason for individual credit taken over the past 30 days. We also noted the current debt held by each adult. The Tsimane' do not utilize formal credit institutions such as banks. Credit types included store credit for commercial goods in town, personal loans, credit with itinerant traders, and loans provided by our research team for medical needs. As a service to the community, we provided informal credit to participants for health emergencies with the condition of repayment in cash or labor. Credit and debt to the research team was coded specifically to identify any influence on the study.

Wealth survey

The accumulation of modern wealth items embodies two separate aspects of economic integration into a market system. First, ownership of physical assets serves as

a proxy for modern wealth accumulation, a trend documented in shifts to capitalism and integration into cash economies (Heilbroner 1985). Second, savings in asset accumulation is a means of delaying consumption to future consumption needs. Savings might provide for a smoothing of consumption in time of shocks or uncertainties (Morduch 1995). Certain items are more likely to have cash equivalents and if necessary be readily sold for cash in the need to buffer shocks. Small animals are examples of assets that can be liquidated in case of minor emergencies (Godoy 2001). These stores of wealth differentiate individuals and households by their ability to access resources during periods of shock, such as death or illness. The functional value of certain items, such as canoes or bicycles, may also indirectly impact one's ability to earn money and access health services by facilitating mobility.

The quarterly survey of wealth was designed to capture both absolute wealth and relative wealth of individuals and households during the 15-month period. During the pilot phase we generated a list of commonly valued market and traditionally produced assets with the help of a Tsimane' informant and the experience of the principal investigator (Godoy). The list included both low and high value items that serve as a measure of market integration (Gross et al. 1979; Putsche 2000). Early into the study we appended the list to include assets typically owned by females after the realization that it was skewed towards male wealth. We ultimately decided on a total of 22 assets. A complete list of market and traditional assets used in the wealth survey appears in Chapter 4.

In the wealth survey we asked about quantity and ownership of each of the 22 items. We used permission to sell a particular asset as the operational definition of

ownership. This survey also included measures of co-ownership for items belonging to children or jointly held by the adults in the households. We collected data on the total number of a particular asset in the household, the total number owned independently by each individual, the total co-owned, and the number of people with whom ownership was shared. When possible, the number of items was verified through direct observation. To calculate individual wealth, the value of an asset was calculated by multiplying the village price by the quantity owed by the individual plus the fraction of co-owned items. We made the assumption that consensus at the village level in market price was accurate for calculating monetary values of items in the income and wealth modules. Despite data collection at the individual-level, wealth data proved to be more useful when aggregated to the household-level and divided by household size as there were some random responses to co-ownership or individual private property; some males if interviewed would claim they alone owned everything.

There often exists a problem when applying the researchers' own cultural interpretation of private property and wealth to a population where that might not be the most appropriate concept. This is important to acknowledge and take into account in discussing the outcomes of quantitative analysis. In San Antonio, we began to take the data books with us to track change in wealth as well as ownership from one quarter to the next. The precision in quantity for large volume items, such as free-running chickens, is somewhat limited and an error margin in counting needs to be assumed. This experience was instructive on a methodological level. Likewise, we observed the tendency to round-off quantities of items by multiples of five or ten.[6]

[6] These lessons contribute to the debate on the limits of "quantifying cultural issues," however attempts are still necessary in order for research results to yield policy or broader application of the findings.

Village price survey

In order to analyze individual and household wealth, each asset needed a calculated monetary value for the particular quarter. One means of accomplishing this is through contingent valuation which involves asking a sample of people about what they think the product, such as a shotgun, is worth in different contexts and then averaging the responses (Kramer et al. 1992). Initially, our team employed this method for establishing village-level prices for wealth items each quarter. Each quarter, we consulted males in the communities who frequently visited the market towns or traded in high volumes on the value of each asset on the wealth survey. Because of their greater mobility and economic activity in the market town, we identified males as the best representatives of price estimations. We asked, "What is this asset worth?" and "What is the price in the community?" for each of the 22 wealth items (Safilios-Rothchild 1988). Often this included an exercise of asking villagers what they would pay for an item, using a unit of exchange such as kilograms of rice or bars of soap. This price included the price plus the costs of transport out to the village.

When an asset had not been recently purchased or trade, the men often lacked a clear knowledge of the price. During preliminary data analysis, it became apparent that some of the items were artificially fluctuating with unusually high variability in prices attached to nonmarketed items such as hunting dogs. To address this problem I decided to use the average quarterly price of each wealth item in San Borja in my analysis calculated from monthly price-data an assistant collected in town rather than the village prices. For items not sold in San Borja, I used the an average of prices reported in the village over all five quarters.

Module 2: Consumption via Weigh Days

Income is not limited to cash and trade, but rather a household's economy is based on the daily consumption of forest, farm, and market resources. This consumption can be estimated through the imputed value of farm and forest production. In order to account for noncash income to households, each quarter, we conducted 11-hour direct observations of household consumption, or "weigh days." Weigh days were conducted as the second module each quarter following the economic surveys described above. Cash and in-kind income affect consumption dictating a time order sequence of consumption after income data. We randomly assigned each household a day for conducting the weigh days. On the designated day a member of the team would arrive in the morning at 7 a.m. and spend the day recording, measuring, and counting each item that entered the physical limits of the household, the person who brought the item, and where she or he got it until 6 p.m. This method served as a direct measure of a typical daily household consumption in the broadest definition. During the weigh day, we recorded the gender and age-disaggregated household composition for analysis of consumption per capita. The total resources "consumed" by the household can be divided by the household composition for that specific day. We used a measure of who was present for the main meal or who slept in the residence the previous night as the estimation for household size (Shell-Duncan and Obiero 2000).

Each item entering the household during the weigh days needed an assigned monetary value. While there are several ways to assign value including nutritional value, exchange value, spiritual value, and economic value, the purpose of my study was to capture the effect of the economic aspect of income on the health and nutritional status of the population. Using the market value presents limitations in that the value may not

represent the true value of the items to the villagers (Wollenberg and Septiani Nawir 1998). There is also a trade-off of comparability across villages. Information on perceptions of the nonmonetary value of items such as prestige and status was garnered throughout the field experience through daily interactions with the Tsimane' (e.g., pasta noodles over rice for festivals; alcohol over *chicha* in the more integrated communities). In a situation where villagers are not accustomed to discussing price values of items because they are only familiar with barter using a *jatata* panel as currency, price proxies are less valid (Wollenberg and Septiani Nawir1998). To manage this, we established imputed values (estimated monetary value not directly derived from cash exchange) for barter and weigh day consumption items (Wollenberg and Septiani Nawir 1998). Many of the items that entered the households during the weigh days are nonmarketed products and intended solely for home consumption. Monetary valuation was difficult as it relies on assumptions or personal opinions about the value. One way in which we addressed this obstacle was through recording the time spent to acquire the resource. Using these data, a monetary value was calculated by multiplying time spent collecting the item by the daily wage (cf. Wollenberg and Septiani Nawir 1998 for detailed discussion of estimating incomes in forest environments).

Module 3: Measures of Illness and Diet

I designed the health component of the study in two parts to capture both perceived and objective measures of individual health status to be used as dependent variables in the multivariate analysis. This third module includes recall surveys of perceived health status and dietary intake. We conducted the illness and diet surveys during a single visit to the household, treating both as subjective measures. In the fourth and final module of the quarterly schedule of data collection, objective measures of nutritional status are

taken and will be discussed in the next section. Individual nutritional status is affected by episodes of illness and dietary intake, thus it followed in the time order sequence.

Self-perceived illness and treatment utilization

Illness and disease can be studied through several methods. Recording health data using symptoms checklists over a designated time period is one common method. Clinical diagnosis of illness, considered a more accurate method, was not possible in this study due to lack of trained medical personal. I decided on self-perceived illness recalls instead of symptoms checklists because I was interested in collecting data on more specific representations of illness and disease. Self-perceived illness recall is one of the most common methods in developing countries (Murray and Chen 1992). Collecting detailed data about a subject's perception of their illness episode affords me flexibility to aggregate data into broader diagnostic categories such as respiratory or gastrointestinal illnesses.

Self-perceived illness was measured for each adult through quarterly recalls of any ailments, sickness episodes, or other claimed health conditions for the period seven days prior to the interview. Interviews were conducted with all members of each household over age 13. Parents, generally mothers, were interviewed regarding their children younger than 13 years of age. Women were selected because they are the household members who have the most regular contact with children and, therefore, are most appropriate for eliciting recent health information. Therefore information about child health was as perceived by the parent or caregiver. We asked if they had experienced any illness or health problems in the past seven days, and if so, to describe the type of illness. In addition to the type of illness, we recorded length of illness in days, number of days confined to the bed, and information on patterns of seeking treatment (Ryan 1998;

Scrimshaw and Hurtado 1987). For each illness, we inquired as to whether or not a treatment was sought for the illness, the specific treatment applied, at what point during the episode it was sought, and the costs in cash or time incurred to the individual or household. Attempts to illicit free-response as to the reason for preference of one treatment type over another proved not to be as useful for quantitative analysis but provided interesting qualitative insights. At the same time, we recorded information on the habits of alcohol, tobacco, coca leaf, and *chicha* (thick corn or manioc beer) consumption for all adults during the last seven days.

Dietary information

The study of diet and nutrition can be achieved by evaluating individual food acquisition, expenditures, diet composition, distribution and availability of food resources, or seasonality through a combination of observations, measurements, and survey interviews. In selecting methods for collecting dietary data, I considered the range of options available. Because of the labor and time required for accurate and detailed food consumption data, researchers often select only a few sample households in a community and study them in-depth during dry and wet seasons for anywhere from three to ten days (Behrens 1986; Forline 1997). Data are then analyzed and extrapolated to generalize about the larger population. Given, that the other components of our study were being addressed at the individual-level, I needed a method that I could use with all the households in the sample to collect data specific to those households rather than generalizing from a smaller sample. Moreover, because we would be living in the communities for 18 months we would be able to collect data more than just during peak dry and wet seasons to capture greater variation in resource availability.

There are trade-offs between precision, sample size, and bias introduced by researcher presence during meals (Pao and Cypel 1996) when planning a dietary study in the field. I decided on twenty-four hour dietary recalls and the accompanying trade-off of a larger sample by recall, over an intrusive observational method. I chose for our team to conduct recalls in all sample households to get at individual-level dietary patterns. Twenty-four hour food recalls are a good option for our field setting in that they are not as invasive as weighed food observations, yet are more specific than food frequencies. It is a method easy to learn and has the advantage of being respondent driven (Cassidy 1994). Limitations to the twenty-four hour recall method include the generation of accurate but not as precise data. Moreover, some foods may systematically go underreported, for example, foods that are eaten away from the home, in small quantities, with less frequency, or are seen as culturally inferior (Ulijaszek and Strickland 1993). Another limitation is knowing the quantities consumed by each individual compared to the quantity prepared by the cook.

Initially, we began this module by visiting households we knew were present in the community on a particular day. After the first quarter, we changed the protocol to ensure more randomized visits. In each community, we grouped households geographically into three or four sections. We then assigned a random order to each group for conducting the surveys. Any absent households were revisited on a fourth day.

Twenty-four hour dietary recalls were conducted quarterly with the household member primarily responsible for food preparation, most often the female head. She often received recall assistance from family members present at the time of interview. The subject was asked to recall all the foods prepared and/or consumed by members of

the household in the twenty-four hours prior to the time of interviews. Typically, we began with the most distant meal. Portion size was difficult to establish, but was aided by the discussion of common containers used by the Tsimane' such as the *tutuma* gourd (*Crescentia cujete*) or plastic drinking cup. The specific foodstuffs and modes of preparation were recorded along with the state (e.g., raw, cooked, ripe, or unripe) and portion size to the possible accuracy allowed under these conditions.

An important limitation to both weighed and recall methods is related to the disjuncture between methods of assessment and the actual eating practices of populations. Food habits that favor group over individual consumption for cultural and or economic reasons make this method difficult to execute (Cassidy 1994). When people eat from a common pot, it is almost impossible to collect individual-level data (Cassidy 1994; DeWalt 1983; Quandt 1996), although the method can be somewhat modified to include direct observation. Mid-way through our field research it became evident that this method was more easily carried out in San Antonio than in Yaranda because people eat from individual plates more often and have better understandings of standard weights and measures. This made it more feasible to achieve individual portions and composition of meals. In Yaranda, there is a greater tendency to eat out of a common pot rather than individual plates that make portion recall less accurate and individual-level data almost impossible. Apart from intrusive observations and measures of actual portions prior to consumption, diet data are difficult to obtain. As it was, this was culturally a strange topic to be studying and we were often met with chuckles when we probed for greater detail about meal composition.

Despite the above mentioned limitations, it was possible to differentiate among market, farm, and forest derived foods. The best attempt was made to record accurate intake data. The Tsimane' have a relatively monotonous diet in any given season, unless there are seasonally gathered or harvested foods, or game. Therefore, our diet data are taken more as a representation of any given day in that quarter (Cassidy 1994) and may be better aggregated to the household-level.

Module 4: Nutritional Status

One of the most widely used methods in the assessment of nutritional status is anthropometric measurement. Anthropometry involves measuring different dimensions of the body to determine aspects of body composition. Several of the most common measures include height, weight, skinfold thickness, and waist and hip circumference. The benefits of selecting anthropometric methods for assessment of certain components of nutritional status include low cost, ease of training, and less user interpretation compared to survey techniques. Another benefit is that these measures are more readily interpreted by the participants and aid the researchers in explaining and sharing results. However, interobserver checks are necessary when using multiple personnel (Ulijaszek and Strickland 1993; Zemel et al.1997). One limitation built into anthropometric measurements is a lack of specificity or the ability of a measurement to estimate causality behind a nutritional problem (Keller 1991). For example, a child who is assessed as short for her or his age may have experienced prolonged periods of nutritional stress, or have two particularly short parents.

Our team obtained anthropometric measurements on each individual to monitor physical growth and development at quarterly intervals. We also asked each woman if she was pregnant and/or lactating at the time of measurement. Every three months we

would set aside several days to conduct anthropometric measurements in communities. Residents were invited to the central meeting area, usually the school (San Antonio) or researcher's house (Yaranda), where equipment was set up in stations. We trained one to two Tsimane' residents with elementary education to assist us in the measurements when additional hands were needed. After participating, subjects received refreshments and cookies for their time and patience. It became a social affair for many and generally there was a positive response, particularly in the more integrated community where residents are more familiar with this type of measurement and outside contact due to annual visits by public health vaccination campaigns. In Yaranda, there was slightly more apprehension on the part of new mothers that we cannot fully explain, but appeared to be related to less familiarity with this type of activity. One adult male in Yaranda refused to be weighed during the course of the study based on his belief that he would become thinner if weighed. He did, however, participate in all other modules of the study. For those participants unable to travel to the school due to work commitments or age, a final two to three days was dedicated to a mobile unit in which we hauled the equipment to the households of missing subjects. The quarterly anthropometric measures included weight, height, body fat through bioelectrical impedance, mid-arm circumference, and skinfolds thickness. Each is discussed below.

Height and weight

Height and weight are two fundamental measures of nutritional status. We measured the heights and weights of subjects while barefoot and without any hair clips or headgear. Subjects were asked to remove any obvious objects from their pockets. In the more integrated community of San Antonio there was a cement floor on which to set up the equipment. There was no comparable surface in Yaranda, so a wood board was

placed under the scale and the anthropometer was placed on the flat packed dirt floor of the researchers' home. Recumbent length, rather than height, was taken for children less than two years old and unable to stand unassisted on the anthropometer's surface (Frisancho 1990). Subjects taller than one meter were measured on the digital Tanita TBF-551 Body Fat Monitor Scale. Children measuring less than one meter in stature were weighed on hanging scales. In a few isolated cases, small infants were weighed with mothers, arriving at their weight by subtracting the mother's weight, an acceptable methodology for these circumstances (Frisancho 1990). For the most part, it was attempted to weigh infants independent of mothers in hanging balances.

Skinfolds thickness

Caloric status and growth progress can be assessed through measures of subcutaneous fat, lipids, triglycerides, hemoglobin, hematocrit, and serum and urinary vitamin concentrations (Garn 1991). A good and less invasive method for assessing variation in energy supplies and lean body mass is the measurement of skinfolds of key locations on the human body (Jelliffe and Jelliffe 1989). A simple caliper is used to measure the fat that pulls away from different sites on the body. Triceps and subscapular skinfolds are the most important sites for measurement (Zemel et al. 1997), and are good indicators of short-term nutritional status. Other areas on the body include the bicep, supra-iliac, inner thigh, and calf skinfolds. Practical considerations such as comfort of the subject with her/his need to remove clothing in order to reach the site factored into our selection. Our team used Lange calipers to take measurements of skinfolds on four sites: triceps, bicep, subscapular, and suprailiac. We also used a flexible measuring tape to measure the upper arm circumference at the midpoint between the elbow and shoulder for calculations of muscle.

Limits in precision or consistency also exist in the skinfold method. Estimating body fat and composition with skinfolds measurements can be plagued by the problem of compressibility, which increases the potential for introduced error. Skinfolds compressibility is age and sex dependent, with variation across body site as well (Frisancho 1990; Garn 1991). Due to changes in skin elasticity in older subjects, there is a tendency to pinch lean matter, as well as fat, leading to overestimations of actual fat stores. Interobserver bias in locating the skin landmarks can also affect results (Bailey 1991; Garn 1991). There was some indication of interobserver error/bias between skinfold measurements taken in San Antonio and Yaranda, specifically in measurement of triceps skinfold thickness.

Clothing adjustments

Layering of clothing can introduce error into anthropometric measurements, particularly with adults where the researcher is unable to measure hip circumference directly on the body. One way to deal with this is a standard adjustment for clothing allowance on the measurements. During our fieldwork, participants often dressed up for the anthropometric measurement days, which might mean women are in full dresses making access to their waists difficult. Because we conducted data in a public rather than clinical setting, it was impractical to expect subjects to disrobe for the measurement. It was more feasible to take direct measurements on the skin of adult males and children while adult females women who wore a one-piece dress had to be measured over clothing. Clothing adjustments were made at the time of recording. We subtracted 0.5 mm from any skinfolds measure taken over clothing.

Other Methodological Notes: Provision of Health Services

As part of our commitment to provide services to the community, the two sets of researchers in the panel study maintained a basic first-aid kit or *botiquín* for minor ailments in each community. We did this in response to a request by the two communities in the initial terms of our research. Although I was initially concerned with the impact of the *botiquín* on the study, ethically we could not refuse this request. To mediate any influence, we kept written record of the individuals, illnesses, and medications disbursed throughout the year. The medical care we provided left a positive impression of our study on the welfare of the communities. Additionally, we intervened in emergency medical situations to facilitate access to medical care including assistance with transportation and loans for treatment.

Conclusion

There are both advantages and limitations to each of the methods we used in the field. Part of developing a good research design involves investigating the range of options available and making decisions about what is feasible in the field given human and economic resource constraints. In my study, three different aspects of human health were measured and serve as the dependent variables in my analysis of market integration and acculturation. Each area, self-perceived health status, diet, and nutritional status, represents a slightly different element of welfare and is subject to modification with changes in economic and social participation. Before discussing the analysis of the data collected using the described methods, I shift the focus to provide ethnographic background and history of the Tsimane' people in the next chapter.

CHAPTER 3
TSIMANE' HISTORY, ETHNOGRAPHIC BACKGROUND, AND MODES OF SUBSISTENCE

> Varios siglos de relacionamiento con la sociedad dominante colonial y republicana, no parecen haber comprometido tanto la sobrevivencia de los grupos étnicos amazónicos de Bolivia como lo hace la penetración capitalista de la últimas décadas y la consecuente expansión del Mercado interno (Rioja Ballivián 1996:150).
>
> Many centuries of contact with the dominant colonial and republican society, does not seem to have compromised the survival of the Amazonian ethnic groups of Bolivia as has capitalist penetration in the last decades and the consequent expansion of the internal market [translation by author, (Rioja Ballivián 1996:150)].

Introduction

The history of the Tsimane' people, like many Amazonian groups, has been influenced by dominant political, social, and economic forces at an increasing pace since the arrival of the Europeans to the Americas. While we know little about the specific social and economic trajectory of the Tsimane' before 500 years ago, common themes of domination, attempted missionization, territorial encroachment, economic integration, and cultural assimilation emerge when examining their history since European contact. These widespread stresses and strains do not manifest themselves in a singular way, but rather, they are multidimensional and affect the cultural and physical survival of tropical peoples in different ways. My dissertation examines the case of one specific ethnic group living in the tropical forests of Bolivia to understand how increased contact, socioeconomic expansion, and economic integration affect their health and welfare. To analyze how more recent pressures affect individual welfare and livelihood it is helpful to

first look back at what is known about the history of this people leading up to the time of research. This chapter presents a brief ethno-history of the Tsimane' people, and describes their political organization and mode of subsistence. The description draws on a review of the available literature on the Tsimane' as well as data and observations collected during my fieldwork.

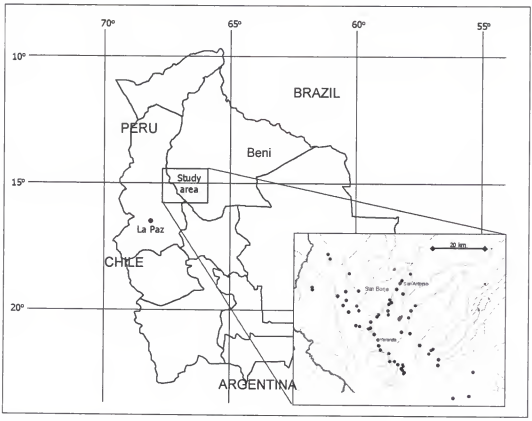

Figure 3-1. Location of the study area within map of Bolivia, courtesy of David Wilkie.

Historical Background

Sources of Information about the Tsimane'

The Tsimane' Amerindians are classified as a Tropical Forest Culture (Lathrap 1970). They inhabit the tropical forest and border savanna regions in the lowland José Ballivián province, of the Beni department of Bolivia (Figure 3-1). The two closest regional population centers to the Tsimane' communities we studied are the towns of San

Borja (pop. ~16,273) and Yucumo (pop. ~3,090) (INE 2001). Historical accounts, even though few deal directly with the Tsimane', allow for a composite understanding of their history in relation to the colonial powers in Bolivia. One important scholar, Erland Nordenskiöld, conducted research in Bolivia in the early part of the twentieth century in the sub-Andean, Chaco, and Amazonian regions. No published archeological studies look specifically at the material remains in Tsimane' occupied territories. There are references to human transformations on the landscape of a people preceding the Tsimane', but not directly to any large-scale society of which they may have been a part. While conducting survey work related to oil exploration for the Bolivia California Petroleum Company and Bolivian Shell Ltd. in 1963, George Plafker attributed features of the forest/savannah regions between San Borja and San Ignacio occupied by the Tsimane' to some preceding group:

> In the region inhabited today by the Tsimane', especially between San Borja and San Ignacio, there are remains of large cannels, dikes, and constructed platforms to drain and convert vast regions into cultivated fields. The elaborate works were made by an industrious population preceding the Tsimane' [translation by author, (Plafker in Portugal Ortiz 1978:31)].

Working elsewhere in the Beni, archaeologist Clark Erickson (2001) continues to investigate raised roads and canals constructed by PreColumbian populations living under similar ecological conditions as the Tsimane'.

The Tsimane' are not unique in their geopolitical history, rather, in a broader sense, they share similar patterns with other peoples of South America's Amazon region (Nordenskiöld 1924; Steward 1948). Knowledge of ethnic groups in the Bolivian lowlands prior to European conquest is varied and concentrated on several larger groups such as the Moxos. There is little specific historical reference to or documentation of the Tsimane' themselves, and recent publications (Chicchón 1992; Ellis 1996; Huanca 1999;

Piland 1991; Reyes-García 2001) summarize the available historical information before adding their own contributions to our knowledge about the Tsimane'. The history of the Tsimane', is therefore, a composite portrait painted by a small group of scholars drawing on limited primary resources that specifically document Tsimane' history. Tsimane' mythologies and oral histories have been recorded by anthropologists Jurgen Riester (1993) and Tomás Huanca (1999). More recent efforts to preserve mythology (Daillant 1994; Mayer and Caymani 2000), ethnobotanical knowledge (Nate, Ista, and Reyes 2001), and hunting practices (Mayer et al. 2000) have been promoted through collaboration with nongovernmental organizations (NGOs) working with indigenous cultures in the Bolivian lowlands and involvement of Tsimane' investigators aided by second-party researchers.

The Mission Period and Ethnic Distinction

Scholars accept that prior to European contact, the Beni region was inhabited by tropical forest chiefdoms (Deneven 1966; Jones 1980). It is not explicit, however, if the Tsimane' were included in one of these groups. Jesuit contact with indigenous groups in the Bolivian Amazon dates back to the 1500s with the initiation of Spanish colonization of the Americas. The arrival of the first Europeans initiated ongoing contact by way of attempted missionization. The written history of missionization in the region in large part focuses on the larger Moxos group with some reference to the Tsimane' (Block 1984; Denevan 1966; Hermosa Virreira 1986; Lathrap 1970). Franciscan priest Gregorio de Bolivar is identified as the first individual to mention Indians in the Moseten/Tsimane' area in 1621 (Metraux 1948:486), in his description of the Spanish myth of a rich kingdom of Moxos, known as El Dorado. The Moxos were successfully missionized

while other native groups including the Yuracare, Siriono', and Tsimane' are described as "marginal" or "savage tribes" because of failed attempts to Christianize them.

Tsimane' ethnogenesis, or origin of a distinct ethnicity, is not entirely certain. Denevan (1966:43) referred to the Tsimane' as one of several "marginal savanna tribes" living in gallery forests, forest patches, and along the margins of the Moxos savanna. Colonial writers mentioned the Tsimane' under various names: Chimanisa, Chumano, Nawazi-Moñtji, and "closely related to Moseten" (Metraux 1948:486). The Moseten, another ethnic group living along the Bopi, Beni, and Quiqiuve Rivers (Metraux 1948), have been described as having links to Aymara groups and may have been subjugated by the Incas. Today, there is some intermarriage between Moseten and Tsimane' and both groups identify as being close relatives. The Moseten and Mojenos also reportedly see the Tsimane' as brave hunters and workers, but at the same time as more primitive because they lack a fixed residence throughout the year, hunt with bow and arrow, and though uncommon, still practice polygyny to some extent (Riester 1993). As will become evident throughout this chapter and dissertation, to characterize all Tsimane' as migratory bow and arrow hunters denies the diversity that exists within the ethnic group today. Nevertheless, comparisons are found in the literature between the Moseten and Tsimane', asserting that the Moseten are more acculturated than the Tsimane'. For example, in 1948 Metraux compared the Moseten to the Tsimane' as "thoroughly acculturated" while the Tsimane' "still retained much of their aboriginal mode of life of 30 years ago" (Metraux 1948:487).

Further comparisons of the Tsimane' to the Moseten allude to an ethnogenesis stemming from missionization efforts. Castillo writes that the Tsimane' "suffered their

first group fracturing in the colonial period when one part of their population, the Mosetenes, were integrated and resettled into the Franciscan Missions" (translation by author, Castillo 1988:5). According to this account, the Tsimane' were then distinguished from the Moseten in that they were not successfully missionized by colonial institutions. Still, it is difficult to document first contacts with the ancestors of present day Tsimane' because of the generic terms used by the colonizers for all Amazonian societies. For example, an early account (1538) by missionaries refers to the lowland Amerindians presumed to be the Tsimane' as "chunchos" (Ellis and Aráuz 1998:2). Likewise, Mission San Borja is documented as having 3000 Indians "de la nacíon churimana" in 1693 (Ellis and Aráuz 1998:3).

Failed Missionization

Beginning in 1668, the Jesuits settled in the Beni region and established more than 25 towns (Reyes-García 2001). Mission San Francisco de Borja was established in 1693 along the banks of the Maniqui River. The present day town of San Borja stands a few kilometers from the site of the original mission. The Indians associated with Mission San Borja have been referenced with various names. There is record of attempts by missionaries to offer trinkets to pacify Movima or Churimana peoples (Chicchón 1992). In the 1690s, Indians in several of the missions in the upper Beni rose up against Dominican priests, setting fire to the buildings. The revolt was led by a nonspecified Moseten/Maniqui/Chimane native group, as a resistance against missionary dominance (Chicchón 1992). Despite their continuous presence in the area for over two centuries, Jesuit efforts did not succeed in converting the Tsimane' to a sedentary society (Dalliant 1994). In 1767, the Spanish Crown expelled the Jesuits from all its territories leading many to speculate that the Indians in the missions must have fled back to the forest at that

time (Chicchón 1992). Hermosa Virreira (1986) provides a map of the forest tribes and Franciscan missions in Bolivia around 1883 which places the Tsimane' in a region without missionary presence, lending support to this assumption. Chicchón (1992) proposes that a lack of centralized Tsimane' leadership and an extensive resource strategy as a pattern of subsistence contributed to their difficult or impossible missionization by Europeans. This apparent failed missionization is significant for the social and economic trajectory of the Tsimane' people during the nineteenth and twentieth centuries as it enabled them to preserve a more autonomous cultural heritage.

Linguistic Origins

Tsimane' linguistic origins are often linked to the language spoken by the Moseten people as part of an isolated Bolivian lowland language family (Chicchón 1992). Denevan states that along with the Moseten, the Tsimane' form an independent linguistic group in the Beni (Denevan 1966; cited by Rioja Ballivián 1996). Their relationship to other South American lowland linguistic groups is less clear, with possible ties to a Macro-Pano family along with the Ge'-Pano-Carib group (Chicchón 1992), the Tacan family group, a Aruaco dialect (Hermosa Virreira 1986), or related to the Arawak speaking Moxos who were gathered into missions (Lathrap 1970). Today, the Tsimane' maintain their own language distinct from the dominant national language of Spanish. While Spanish facilitates market interaction, it is known to varying degrees with better comprehension among males and the political elite. Twentieth century protestant missionaries were the first to transcribe the Tsimane' language and continue to compile dictionaries and grammars.

Bolivian Independence and Economic Development in the Beni

In 1825, Bolivia gained its independence from Spain. The Republican era is characterized by the extraction of natural resources from the Beni region. From 1882 forward, white migration into the Beni increased as opportunities for economic exploitation through extractive activities grew. Resources of interest for the international market included vanilla, quinine, cacao, and later rubber. The indigenous peoples of the Beni were used as slave labor in the rubber industry, an abuse common throughout the Amazon. The population increase in the Beni during the rubber boom led to greater market demand for beef resulting in the growth of cattle ranching in the region.

In 1912, the rubber market collapsed and cattle ranching took over as the dominant economic activity in the Beni (Jones 1980). The white elite built large ranching estates and continued to rely on the indigenous people as a source of cheap labor. In the 1940s, a rise in national beef prices made cattle ranching an even more lucrative and attractive endeavor (Jones 1980). The advent of air transport into the Beni department supported the increase in supply to meet the growing demand. During the same period, a market for animal pelts, such as black caiman, involved native groups in roles as forest guides and later traders. Agrarian Reform policies favoring colonization of the Bolivia's tropical lowland departments in 1953 made large ranches in savanna lands legal property of individuals. The ongoing expansion of the cattle industry has led to the cutting of forestlands to make way for additional pasture (Piland 1991).

In 1975 a road linking San Borja to the departmental capital of Trinidad facilitated colonization programs and export of goods from the Beni. Quechua and Aymara colonists flocked to the Beni in search of a new life and to escape poor quality and

limited land resources in the highlands. They primarily engaged in rice cultivation and some logging activities (Reyes-García 2001).

In more recent times, the Beni region, specifically San Borja, has earned an illustrious reputation through a history of involvement in the processing of coca leaf for the cocaine industry. These activities, which flourished throughout the 1980s, did not directly affect the Tsimane' and have reportedly ceased or at least declined significantly today. Many of the contemporary elites running San Borja have an infamous history of wealth acquisition. Today, logging and ranching are the dominant economic activities with colonist-led agriculture important as well.

Twentieth Century Missionary Influence

Catholics

The 1950s have been described as a re-awakening of the missionary movement that would profoundly affect the Tsimane' (Chicchón 1992). During this period, Catholic missionaries from the Redemptionist order arrived to the upper Maniqui River. They established a mission at Cara Cara in 1953. Later the mission was moved to an offshoot of the Maniqui River, the Rio Tsimane', and renamed Misión Fátima. Several priests passed through Fátima, with the most significant impact made by Padre Martín Baur who arrived in1958 with the intent of teaching cattle ranching techniques to the Tsimane' (Chicchón 1992; Frésand Joly and Moreo Cuella 1999). Padre Martín lived with the Tsimane' in Misión Fátima from 1958 to 1996 when he left for health reasons and died the following year. While he failed in a large-scale introduction of cash crops of cacao and coffee, he established a mission health post and school, training two Tsimane' women as nuns in the Catholic Church. The physical structure of Misión Fátima still endures today with some activities organized by the Tsimane' living in the community,

however, there is no missionary stationed there. During our research from 1999-2000, Tsimane' residents of the community of Misión Fátima are not welcoming to anthropologists or other outsiders who might travel up the Maniqui to the Rio Chiman where the mission stands.

New Tribes

Another twentieth century missionary force, which continues to influence the Tsimane', is the Misión Evangéliga Nuevas Tribus (New Tribes Mission) based out of San Borja. New Tribes was founded in 1940 to offer assistance to ethnic groups marginalized from national cultures (Castro Mantilla 1997). Their international headquarters are located in Sanford, Florida. New Tribes entered into Bolivia and was officially recognized as a legal body in 1943. The evangelical protestant organization has worked with eight indigenous groups in Bolivia, including the Tsimane', offering linguistic studies, training of bilingual teachers and health promoters, establishing health posts, donating medicines, initiating agricultural and livestock programs, and completing their moral and spiritual mandate by translating the Bible into the Tsimane' language. Their center of operation, Horeb, is located on the periphery of San Borja and run by two American couples belonging to the organization. The initial strategy of New Tribes was for missionary families to establish residence among the Tsimane' in the community of La Cruz, translate the Bible, and work on producing religious and educational materials in the Tsimane' language. Later, the New Tribes became a voice against the exploitive relationships between river traders and the Tsimane'.

In 1989, New Tribes backed the organizing of the Gran Consejo Tsimane', the officially recognized leadership body of the ethnic group whose purpose at inception was to represent the forest interests of the Tsimane' population. The formation of the Consejo

can be analyzed from two perspectives. On the one hand, it is a form of resistance to threats of encroachment on Tsimane' occupied territory, while at the same time, it is also a symbol of Tsimane' acculturation into the politics of power and privilege as the close-knit, well-educated Consejo members spend resources on maintaining their image and legitimacy under *camba* (Spanish term for lowland white Bolivian culture) norms which include public displays of material wealth. Members of the Consejo have privileged access to resources marking a distinct socioeconomic stratification among the Tsimane' people. In a publication by members of New Tribes, the Consejo's president is claimed to have stated that the older members of the ethnic group are illiterate and alcoholics and therefore unable to represent on behalf of the group to the Bolivian government (Kempf and Kempf 1996).

Within the last half-century, religious conversion has operated as a strong mode of cultural assimilation for many of the Tsimane', particularly through the opportunity of bilingual education. The New Tribes mission provided many Tsimane' with an opportunity to learn Spanish and study in mission schools. In September 2000, close to 30 Tsimane' adults (two of whom were female[7]) graduated with high school diplomas. This was a significant achievement for the Tsimane' people as a whole and in large part attributed to the initial push by New Tribes to train bilingual teachers. The majority of Tsimane' teachers have come from the New Tribes adopted community of La Cruz.

Another fundamental influence of missionary presence has been the altering of traditional settlement patterns (Rioja Ballivián 1996). The Tsimane' traditionally practiced a high degree of seasonal migration through visits to extended family

[7] One of the women is the wife of the professor in San Antonio.

settlements. The presence of the evangelical mission and the establishment of schools encouraged settlement of households in closer proximity around newly organized community hubs. There are still some households that prefer to be more isolated, but tend to become marginalized as the schools and soccer fields have become the focus of community social activity. Dalliant (1994) noted that settlements used to be organized in a west-east, circular fashion with a chief at one end and a shaman at the other. She also described a history of Tsimane' shamans able to communicate with the spirit-owners of the trees, salt, animals, fish, and ancestors, but few recognized shamans exist today. One example of Tsimane' beliefs about residences maintained today is the practice of burning the residential structures when a death or serious illness occurs in the household. A new home is then built to avoid evil spirits (Ellis and Aráuz 1998; Pérez Diez 1985).

Chicchón (1992) views community formation as a reaction/response to several factors including land restrictions, the construction of schools, and the establishment of a *corrigedor* representative parallel to the national system adopted by other native groups. It could be argued that there was no organized authority at the general group-level until the New Tribes Missionaries came to work with the Tsimane'. The organization has made significant contributions to the improvement of Tsimane' education while at the same time created greater social inequality as only a small group gained skills through acculturation and teacher training.

The influence of New Tribes on the religious orientation of the Tsimane' varies, often depending on proximity to communities where they have had a greater presence. Traditionally animistic (Reyes-García 2001; Riester 1976), many Tsimane' self-report being nominally Catholic or Evangelical without any active participation in the religion.

Still others attend workshops at Horeb and can be found reading the Bible translated into Tsimane'. In the more remote study community of Yaranda a group of residents gather on Sundays to listen to cassettes with religious messages prepared by New Tribes and recorded in the Tsimane' language.

Social Organization

Political Organization

Nordenskiöld's recounting of Tsimane' social organization in 1922 noted an absence of chiefs or adults commanding one another. The following quote by him describes an inability for Tsimane' to act together and improve their lot against white incursion due to the individualistic nature of the society.

> Para ellos actuar en común es imposible porque cada uno tiene su propio camino y no es otra razón por la que los chimane no puedan levantarse. Su mayor arma de defensa es escapar; selva adentro, dejando sin amparo a los flojos blancos (Nordenskiöld quoted in Riester 1993:96).
>
> For them, acting together is impossible because each one has their own path and there is no other reason in that the Tsimane' could rise up in protest. Their best defense is to escape into the jungle, leaving the slow whites without defense [translation by author].

In 1988, Castillo described the Tsimane' as a classless society, apart from age and gender categories carrying certain privileges and social differences. Fourteen years later, this characterization, whether originally accurate or not, does not hold. The all-male members of the Gran Consejo Tsimane' enjoy a privileged status of access to resources, respect, and opportunity not afforded to the general members of the ethnic group. They show clear signs of acculturation, adopting the Borjano emphasis on material wealth. Tsimane' teachers and their families also enjoy a position of status based on their educational attainment, authority in the community, and acculturation. While there does not exist the exaggerated *machismo* characteristic of Bolivian *camba* culture, there is

some marginalization of women in decision-making. Most of the trained teachers and all community leaders are male. Within each community there are three authority roles or representatives of the community to the Gran Consejo and to outside groups: the *Corrigedor* (chief), *Presidente de Junta Escolar* (President of School Union), and *Alcalde* (Mayor), based on a common system used within Bolivian communities. These roles are held exclusively by males and lack any component of systematic rotation.

The larger body of Tsimane' people does not actively participate in local or national politics to any significant extent. During political campaigns, candidates for local municipal offices visit the easily accessible communities such as San Antonio and give speeches to community members. One tactic employed by campaigning politicians is to send individuals familiar with the communities ahead, such as agronomists from development projects, to earn the trust of the residents. The Tsimane' speak of rumored donations of rice or other food staples by candidates and will drop their work to flock to another community with the hope of a donation. By casual observation, it is estimated that less than 25% of the residents of San Antonio were even registered to vote in the elections of November 1999. However, on election day, I observed many residents of nearby communities in line to vote in San Borja without a registration card.

Kinship System

Traditional Tsimane' marriage patterns followed a Dravidian system of cross-cousin unions (Dalliant 1994). This is followed by marriage with one's mother's brother's daughter or son, or father's sister's son or daughter (Chicchón 1992; Dalliant 1994). This cultural form of prescribed marriage pattern has eroded and cannot be consistently documented in the present time. From our study in the remote community of Yaranda, the researchers noted the abundance of single males of marital age without

anyone appropriate to marry according to the above prescribed rules. By contrast, in the more integrated community of San Antonio, there are several examples of exogamous unions with non-Tsimane'. With these mixed marriages, there is a tendency for the ethnic identity to be diluted through a preference in Spanish language acquisition and communication for the offspring rather than the Tsimane' language.

Post marital residence patterns have been described as initially matrilocal (Chicchón 1992) with some polygyny and only rare cases of polyandry (Dalliant 1994). The evangelical protestant missionaries discouraged polygyny and incorporated this teaching into the schools. A few cases of sorrel polygyny have been documented recently (Huanca 1999; Reyes-García 2001; Rioja-Ballivián 1996). A 1996 survey conducted by Godoy found polygyny among the Tsimane' to be around five percent.

Territorial Rights and History

> La Conquista no ha cambiado en su esencia; ha cambiado en su forma y su métodos, pero el contenido sigue siendo el mismo: conquistarlo para fines ajenas a los indigenas (Riester 1993:12).
>
> The Conquest has not changed in its essence; it has changed in its form and method, but the content continues to be the same: conquering for interests foreign to indigenous peoples [translated by author].

There is no individual land tenure among the Tsimane'. Land is considered to be under communal ownership of the residents of a community. Tsimane' land tenure interests have undergone steady assault from more powerful interests. In the past century, despite advances made in the process of land titling, traditionally occupied Tsimane' territories remain vulnerable. The expansion of logging activities into the Beni region in the 1970s threatened forest resources in territories occupied by the Tsimane' as well as other indigenous groups. As a response to logging activities, in 1978 the Bolivian government created the Chimane Forest Reserve (Reserva Forestal de Immovilización

"Chimane") through Supreme Decree 15585. In 1986, the status was changed to Bosque de Producción Permanente through Supreme Decree 21483 (Rioja et al. 1993:227), making logging concessions possible in the territory. This essentially undermined any notion of a protected reserve. In October 1982, the Estación Biológica del Beni (EBB) was created as a protected area through requests of the Bolivian National Academy of Sciences. The EBB includes part of the Tsimane' territory along the lower Maniqui bordering the community of San Antonio. After failing to recognize the presence of indigenous people in the reserve, UNESCO re-assigned it as a Man in the Biosphere designation in 1986 (Chicchón 1992:3). The EBB gained international recognition in 1988 as the first case of national debt for nature exchange when funds were allotted for conservation activities and administration negotiated through Conservation International (Piland 1991).

In line with the initial purpose of the Gran Consejo Tsimane' to represent Tsimane' territory interests, the first act of the newly formed Consejo on May 4, 1989 was to gain recognition of Tsimane' territory. Prior to any formal leadership body, the Tsimane' were more vulnerable to traders introducing alcohol as a means of exploiting indigenous labor, to loggers illegally cutting down their forests, and to colonists dynamiting their river resources. Similar land rights and encroachments are prominent issues for other indigenous in the region as well. In 1990 indigenous peoples of the Beni demonstrated in the *Marcha por la Dignidad y el Territorio*. More than 700 indigenous people from various lowland groups marched for more than 650 km for a total of 34 days up to the national capital of La Paz. Tsimane' participation in the event was low, given that they

were granted their own territory through a Supreme Decree by the national government a few days prior (Rioja Ballivián 1996).

Despite the national policies and protection efforts by the EBB, Tsimane' occupied land is still at risk of encroachment. In the larger cross-section survey of 58 communities conducted within this research, we found communities to report an average of 6.5 conflicts with outside interests over the last 12 months. These include conflicts with ranchers, loggers, colonists, other communities, and traders. At the end of our fieldwork in 2000, an attempt to sort out legitimate third party land claims from unverified claims of ownership within Tsimane' was underway. The process involved plotting the claimed land boundaries of all third parties occupying the area. This includes private settlers, cattle ranchers, and collective colonial migrants. To some extent, the Tsimane' have been successful in defending their territory for the last few decades of the twentieth century by rejecting external influences and preserving their own norms and values (Riester 1993). However, threats to their territory are increasing through migration and settlement by highland colonists as well as encroachment by loggers and cattle ranchers. San Antonio, which is bordered by the mestizo community of Santa Elena, is particularly subject to encroachment as lowland mestizo and highland colonist expansion presses up against and threatens community boundaries.

Population

Today, the majority of Tsimane' households are congregated within gallery forests in communities or household clusters along the Maniqui River. Smaller populations of Tsimane' also reside in the Pilon Lajas Reserve, Multiethnic Territory, and the Isiboro-Secure National Park (Huanca 1999). As with many remote indigenous groups, particularly in tropical forest climates, there is little accurate national-level demographic

data on this group. Recent population figures were 5,124 in 1995 (Government of Bolivia 1995) and 7,385 in 1999 (Vice Ministry of Indigenous Affairs 1999). Their marginal geographic location has been overlooked during census taking and formal record keeping is not part of the institutional structures with which they come in contact. There has also been difficulty in estimating the Tsimane' population due to movement between settled areas. My own experience living with the Tsimane' informs me that the problem is primarily a lack of effort on the part of national agencies to venture out to Tsimane' communities and count, rather than the mobility patterns of the Tsimane'. Toward the end of our fieldwork we observed the efforts by national census representatives to include Tsimane' households for the 2000 census by labeling residential structures in preparation for the count.

Tsimane' Modes of Subsistence

At present, the Tsimane' mode of subsistence can be categorized as forager-horticulture. Tsimane' households rely on acquiring food resources and other necessary subsistence items from fishing, hunting, gathering, and cultivating crops on agricultural plots in or near their villages. Over the past 50 years there has been increasing involvement in the market economy. Thus, added to this complex livelihood strategy are market-acquired resources. Each of the components of the Tsimane' livelihood strategy is described below.

Horticulture

In a study of Tsimane' agricultural methods, Piland (1991) concluded that the Tsimane' are better classified as forest horticulturalists, than as pure foragers, because of the proportion of their caloric intake coming from their fields. Here, I employ the classification of forager horticulturalists to distinguish them primarily through their

economically productive activities. Lee and Daly (1999) define foraging as subsistence based on hunting, gathering, and fishing with no domestication of plants or animals, except the dog. This fits well into the image of hunter-gatherers surviving exclusively off of wild resources. However, empirical study informs us that not all foraging groups fall into this strict definition, and most in fact, participate in subsistence-level cultivation or horticulture (Carneiro 1974). Features that distinguish horticulturalists from other social and economic forms of organization include the following typology outlined by Johnson (1989): geographical distribution in the humid tropics, slash and burn methods of subsistence-level cultivation, nuclear or extended family domestic production units, village settlement, warfare, political leaders with a resource role, and only rare cases of communal technology. There is variation from this typology and many horticulturalists rely on hunting, fishing, and gathering of wild foods to supplement cultivated crops, particularly as sources of fats and protein. Essentially, the composite label of forager-horticulturalists describes a system where people forage for wild resources to complement cultivated products.

Traditional Tsimane' crop production includes cultivation of manioc, maize, plantains, peanuts, cotton, sweet potatoes, pineapple, and peach palm (Lathrap 1970:58) for home consumption. As it is difficult to preserve crops in the archaeological record in humid climates, much of the evidence is indirect, namely large pottery linked to manioc beer consumption and fiestas (Lathrap 1970). Consistent with other manioc-based cultural systems in the Amazon region (Dufour 1988), the Tsimane' grow sweet varieties mainly for consumption as fermented porridge (shocdye' in Tsimane'; *chicha* in Spanish), or a processed fine flour known in Bolivia as *chive*. Early Jesuit explorers

noted large maize fields, grown mainly for *chicha*. They observed the grinding of roasted maize on stone platters (Denevan 1966:101). The Jesuits were responsible for introducing cattle and African crops brought from Europe (e.g., rice, sugar cane, coffee, and citrus–tamarind, oranges, lemons) into the Beni (Dalliant 1994). Rice is one of the most important crops today for both home consumption and sale in the market. The Jesuits probably introduced cacao (Denevan 1966:102) to the Moxos region although there is wild cacao found in the forests.

Swidden cultivation, also known as slash and burn agriculture or shifting cultivation, is a method of small-scale farming practiced throughout the Amazon. The Tsimane' open plots averaging half a hectare (Vadez et al. 2003) using steel machetes and axes each year for planting, beginning in late-May to August during the dry season (Figure 3-2). Once all the trees are felled, the field is left to dry out before burning can take place in late August to early October. After burning, a field is partially cleared and then planted. The fields may be weeded once or twice before the harvest season. After one or two seasons of cultivation, a plot is left fallow and often fruit trees are harvested intermittently (cf. Huanca 1999 for detailed study of traditional fallow management practices). This method of cultivation results in a variety of plots under different stages of use and management (Dufour 1990). The Tsimane' do not traditionally use any herbicides or pesticides on their fields. In recent years, some households have occasionally used backpack sprayers acquired through agricultural projects to deliver herbicides to their crops. However, the cost of buying the chemicals and problems with early rains deter wider adoption of the innovation.

Adult males take the primary role in the preparation of fields through felling of large trees, clearing of smaller debris, and burning of dried plots. Males as young as 13 years of age may work their own field. Labor is often shared within a household or with kin, but there is no formally organized institution of communal labor. Adult females work alongside males in the fields, but to a lesser extent. Women do not typically have their own field per se, barring an absence of a spouse due to temporary labor migration. After burning and drying, logs from the plots serve as firewood for the household. Typically any adult female or male working in the field will bring in wood at the end of the day or for the mid-day meal. If not, women are more likely to locate firewood from nearby fields and bring it for cooking and heating purposes. Once the fields are planted, they are left to be rain irrigated usually commencing in October. Tsimane' women participate more in harvesting of crops such as rice and manioc as well as secondary processing into edible states. The processing of raw food crops is very time consuming and something that women are involved in everyday to some extent. Older children are often found assisting in the cutting of rice or other harvest activities.

Other crops have been introduced through agro-forestry projects in the study communities. One project in San Antonio introduced the intentional cultivation of mahogany and coffee in fallow plots. The planting of mahogany was a direct response to the decline in trees due to logging and the potential high long-term value for Tsimane' households. These mahogany trees have been plagued by pests and fire but some stands continue to grow.

Month	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April
Study Quarter	Pilot Phase & Quarter 4 *May 10 – Aug. 9*			Quarters 1 & 5 *Aug. 10 - Nov. 9*			Quarter 2 *Nov. 10 - Feb. 9*			Quarter 3 *Feb. 10 – May 9*		
Season	Cold Fronts and Winds			Dry	Dry	Dry	Dry/Wet		Very Wet		Wet	Wet
Climate	Cool Dry Season						Rainy and Hot Season					
Crops *Rice*		Cut Forest/Burn		Burn/Plant	Plant		Weed		Rice Harvest			
Maize		Harvest soft var.		Plant hard/soft		Plant hard		Harvest hard/soft		Harvest hard var.		
Manioc				Plant		Fruit Trees				Harvest begins/continues		
Labor			Agricultural Wage Labor									
Hunting & Fishing	Prime Hunting											
				River levels low-high fishing								
School	In session		2 weeks off	In session/ends	Teacher Training		Vacation			School starts/in session		
Market Sales	Maize sales				Palm mats, Honey, Balsa, Avocado					Maize sales		
	Rice sales			Jatata sales Manioc sales							Rice sales	

Figure 3-2. Seasonal calendar of productive activities. Compiled from information in (Huanca et al. 2002) and interviews with Tsimane' adults during fieldwork.

From an examination of plot size, our study showed that average field size is significantly larger in San Antonio (0.75 hectares) compared to Yaranda (0.35 hectares) (Vadez et al. 2003). Residents of San Antonio on average plant larger fields requiring more labor and time with the hope of commercializing the surplus. By comparison, in Yaranda fields are smaller and more intended for home consumption.

Housegardens

The Tsimane' grow a variety of horticultures including onions, squash, watermelons, peanuts, and garlic, as well as medicinal and ornamental plants in small plots close to the residence or in fallow land (cf. Piland 1992). Tobacco is grown for both recreational and medicinal purposes. Piland (1992) studied Tsimane' agriculture and soil usage in communities similar to San Antonio and Yaranda. He detailed the use of housegardens and the species most frequently raised. Fruit trees, especially citrus, mangos, pacay (*Inga sp.)*, coquino (*Ardisia sp)*, avocado, and peach palm are grown. Papaya grows rampantly by natural dispersion of seeds, and does not require human assisted planting. Some households plant sugar cane and cacao trees in their fields as well.

In July 1999, a Bolivian NGO, PRODESIB (Proyecto de Desarollo Sostenible de los Pueblos Indígenas del Beni), began a horticultural project in San Antonio with the goal of teaching techniques for growing tomatoes, green peppers, and radishes from seeds. The objective was to diversify the Tsimane' diet and potentially provide a new marketable crop. While it first appeared to be a potentially successful project, it soon became evident that there were many problems to project implementation and sustainability. The marketability was not well researched. After a week of training, the communal garden plot was left for the community members to care for it as a common

resource. The unpopular responsibility of manually irrigating the field fell on a few households that resided in close proximity to the communal plot. When seedlings developed, participating households transplanted them to their own gardens with varied success. During interviews throughout the year we would see evidence of new plants in a few households, but on the whole, the project did not approach a sustainable level.

Gathering of Forest Resources

Amerindians have a variety of documented uses of plants gathered from the tropical forests in Amazonia (Dufour 1990). The Tsimane' use an array of plant species found in the surrounding forests for firewood, fish poisons, housing construction, tool manufacture, craft production, jewelry, medicines, and human consumption (cf. Nate, Ista, and Reyes 2001 for detailed descriptions and catalog of useful plants). Edible forest plants and fruits include wild cacao and seasonally available wild fruits. The special case of *jatata* palm (*Geonoma deversa*) extraction will be described later during the discussion of articulation with the market economy.

As the Tsimane' become more integrated into the market economy there is concern over a devaluation and loss of traditional knowledge of potential uses for botanical resources. There is a broad consensual domain of Tsimane' ethnobotanical knowledge between the different villages in which the population is dispersed, and an even greater degree of shared knowledge by individuals living within the same village (Reyes-García et al. 2003). However, there is evidence to indicate an erosion of shared knowledge through economic specialization in communities more integrated into the market economy (Reyes-García 2001).

Fishing

The dispersed settlement patterns employed by the Tsimane' have been explained as an attempt not to exhaust available resources (Metraux 1948). As a major concentration of the population lives along the Maniqui River or other small rivers, fishing has been cited as a more important activity for procuring food resources than hunting (Metraux 1948; Pérez 2001; Reyes-García 2001). Unlike hunting which is almost exclusively a male activity, fishing is practiced by women, men, and children (Chicchón 1992; CIDDEBENI 1990; Pérez 2001). The Tsimane' employ several fishing technologies including metal fish hooks, fishing nets or mosquito netting, machetes, natural poisons, and weirs. Traditional fishing technology is defined by Pérez (2001) as the use of implements produced with local materials from the natural environment (e.g., poisons and weirs). He found a greater use of traditional fishing technologies in the more remote Yaranda and more use of introduced technologies in San Antonio. Fishing practices have been influenced by pressures from external forces. *Barbasco* or fish poisoning techniques provide one of the highest daily yields for consumption compared to hunting or hook and line fishing. However, due to claims of indiscriminate depletion by species and age, the EBB has pressured the Tsimane' on the lower Maniqui to curb this practice (Pérez 2001). These influences could have implications for dietary differences between the two communities, specifically in available sources of protein (see Chapter 7 for a detailed discussion of Tsimane' diet). Contrary to expectation, Pérez found no evidence of more intense activity or increased pressure on fish populations in San Antonio than in Yaranda despite these differences in technologies, nor did he find evidence of induced fishing to meet market demand. In fact, only rarely did residents of San Antonio sell fish in San Borja.

Hunting

Tsimane' men traditionally hunted with hand-made bows and arrows. Today more and more male adults and teenagers use rifles and shotguns to hunt game. We found that many younger males are not skilled in crafting or use of the bow and arrow. While not all Tsimane' men own rifles or shotguns, largely due to their high price, most are competent in the use of either one or the other and borrowing of firearms between relatives is common. When firearms are used, men in San Antonio prefer hunting rifles while shotguns are more common in Yaranda. Tsimane' men and boys in Yaranda also use the bow and arrow during *barbasco* fishing which might explain its persistence upriver and decline in San Antonio where this technology has transformed more into a craft for sale in San Borja (Apaza Vargas 2002). Greater access to cash for the purchase of firearms is also attributed to their higher prevalence in San Antonio.

The Tsimane' hunt game in the open savanna, gallery forests, and *islas del bosque* (islands of forest) around their settlements. Short overnight expeditions are common in the more market-centered areas, while longer multi-day trips are recorded in the more isolated areas. They typically hunt game within a 3 km radius from village settlements (Apaza et al. 2002). The importance of dreams in predicting hunting success has been recently documented through oral histories and Tsimane' mythology (Mayer Roca et al. 2000).

Mammals are disproportionately the most common animals hunted in both communities. Commonly hunted game include collard peccary (*Tayassu tajacu*), white-lipped peccary (*Tayassu pecari*), agouti (*Dasyprocta spp.*), red brocket deer (*Mazama americana*), howler monkey (*Alouatta caraya*), squirrel monkey (*Saimiri sciureus*), and armadillo (*Dasypus novemcinctus*). Birds make up 13-15% of game hunted in Yaranda

and San Antonio, respectively (Apaza Vargas 2002). Meat is preserved through techniques of salting and sun drying raw pieces into *charqui* or by smoking. Hunted game is often shared between extended families, although we found less observance of this practice in the more integrated community of San Antonio.

Animal husbandry

Tsimane' households raise chickens, some pigs, ducks, and occasionally goats or cattle. They do not actively feed their animals nor build specialized structures or corrals; rather, they allow the animals to forage freely about the area surrounding the residential unit and plots. In Yaranda, there is a higher proportion of pigs roaming the community and it is common to have to detour around their droppings. These domesticated animals are not a regular part of the Tsimane' protein supply. During our residence in the two villages, households would often claim they have no meat, yet chickens would be running free in the patio. By shush (meat), the Tsimane' are specifically referring to hunted game or beef. Instead, small farm animals function more as a stock of wealth. Pigs and chickens are easily converted into cash or bartered for manufactured goods in town or with traders. They are also eaten during ritual celebrations such as birthdays.

Economic Participation In The Market Economy

Traditionally, the Tsimane' have participated in the regional economy through sales and barter of forest products (Rioja 1992). Over the past few decades the degree of involvement in the market economy has increased along with the availability of more wage labor opportunities. However, a range of level of integration is still found. Interactions with whites, referred to as jaibas (whites) or napos (non-Tsimane') are marked mostly through economic relations. Tsimane' who live in proximity to San Borja have high a high degree of contact with napos.

At present, the Tsimane' are articulated with the market economy through 1) the direct cash sale of their agricultural goods and forest products, 2) barter of these same items with different actors and locales, 3) several types of wage labor, and 4) as consumers of goods and services. In Chapter 4, I provide the specific analysis of individual and household levels measures of integration to the market.

Sale of Goods

Table 3-1 lists the most important commodities by frequency of sale or barter by community.[8] There are two different types of exchange economies in place, one that is dominated by the *jatata* trade in Yaranda accounting for 60% of all exchanges, and another that is primarily based on agricultural and, to a lesser extent, forest products in San Antonio. There is a broader range of products sold by residents of San Antonio.

Table 3-1. Most frequent goods traded through sale or barter by community percent of total number of exchanges recorded

San Antonio 623 Transactions			Yaranda 191 Transactions		
Item	n	%	Item	n	%
Plantains	141	23%	*Jatata*	115	60%
Rice	85	14%	Rice	23	12%
Palm Mats	57	9%	Chickens	16	8%
Manioc	53	9%	Plantains	7	4%
Honey	51	8%			
Cacao	40	6%			
Corn	31	5%			

Rice is the principal agricultural commodity sold by Tsimane' in the San Borja market. Because the Tsimane' do not have their own rice mills, they have the limited options of either selling rice un-milled for a lower price, or paying to mill it with the expectation that the higher price commanded by milled rice will cover the costs of milling. More often, intermediaries purchase the un-milled rice and mill it for resale in

[8] Table 3-1 does not reflect value or quantity of items traded, but rather occurrence of an exchange.

the markets of San Borja. Manioc, maize, and plantains are the other main crops marketed in town by the Tsimane'. Manioc is heavy by volume and commands a low price per *arroba* [9] of only 6 Bs. relative to equal volumes of rice (10 Bs.) or maize (13 Bs.) (Table 3-2).

Table 3-2. Average unit sale prices for top commodities over 5 quarters

Commodity	Average Unity Price in Bs.
Rice –1 arroba unmilled	10
Manioc – 1 arroba	6
Maize grains – 1 arroba	13
Chicken – 1 animal	18
Plantains – 1 bunch	1
Plantains – 1 branch	6
Honey – 1 liter	13
Palm mat –1 mat	9
Cacao – 1 kg.	6
Jatata – 1 panel	1.38

Market demand for goods produced by the Tsimane' exhibits strong seasonality. For example, in the weeks leading up to the Festival of San Borja held from October 10-12, demand for woven palm mats (*esteras*) used in exhibit stalls, beaded jewelry for parade costumes, and nut rings reaches its annual peak. Many Tsimane' living in communities close to San Borja opt to concentrate on the production and sale of these items. Income from sales or trade in San Antonio follows the seasonal cycle of available products including rice, honey, balsa flower, palm mats, and avocados from September to November. The cotton-like flower of the balsa tree is also collected and sold as stuffing for mattresses and pillows. Honey is gathered from the forest and sold door-to-door to town residents. Residents of San Antonio sell plantains year round with the lowest period of sales in October and November.

[9] 1 arroba = 25 lbs. or 11.4 kg.

There is a pattern of increasing cash sales of agricultural products by Tsimane' living in communities close to the market town, cattle ranches, or logging camps. In an analysis of the data from our cross-sectional study Reyes-García (2001) found an inverse relation between sale of goods and distance from a market town. Furthermore, she also found that households farther from the market rely more heavily on barter as a source of income than cash sale.

Barter of Goods

There is historical evidence that the Tsimane' exchanged forest and agricultural products for metal tools with other indigenous groups (Riester 1993). However, during our research, our team did not observe or record evidence to support trade with other native groups as a key part of Tsimane' resource strategies. What we found is that the Tsimane' economy is oriented toward barter exchange with intermediaries and direct sales to consumers originating outside of the community.

The two study communities are integrated into the market economy through different types of barter relations including itinerant traders, cattle ranchers, and mestizo settlers. In his study of three Tsimane' communities, Piland (1992) reported barter with traders as the most frequent mode of exchange. In our study, we found this to vary greatly by ecological zone (presence or absence of *jatata*) and distance from the market. Residents of San Antonio and other lower Maniqui River communities make more frequent day trips by foot into San Borja to complete cash sales and are much less dependent on in-kind barter relations with traders than residents farther downriver or in the upper Maniqui. Distance from San Borja precludes this type of activity for more remote communities and residents rely heavily on barter with traders. Items bartered on the lower Maniqui primarily consist of agricultural products and small animals. In

contrast, in Yaranda and other Tsimane' communities in the upper Maniqui River, residents primarily trade one specific commodity, *jatata* thatch panels. The two different barter economies are described below.

Barter relations on the lower Maniqui River

Tsimane' living in communities on the lower Maniqui River barter goods primarily with ambulant traders, cattle ranchers, or mestizo farmers. Ambulant traders frequent Tsimane' communities close to San Borja trading consumer products such as used clothing, plastic containers, and bread (a novelty food for the Tsimane'), in exchange for agricultural products they will resell in town. Traders may reach the communities by canoe, bicycle, motorcycle, or horse. They generally work on a credit system leaving the market item and planning future dates for pick-up of the agricultural products. In San Antonio, barter is a less frequent or predictable economic activity than cash sales. On occasion, one or two individuals from town pass through San Antonio on bicycle or by river informally trading bread or other market goods in search of rice, chickens, and other crops. This can be more of a novelty to the Tsimane' than a necessary means of acquiring market items.

The Tsimane' living in the lower Maniqui River also barter their agricultural goods to neighboring cattle ranchers or other residents of the savanna and forestlands. Cattle ranchers need to provision their laborers and households with crop staples that they do not grow. Payment from ranchers is most often in meat, milk, or cheese. Annually, the community of San Antonio purchases a small cow for their festival by trading a large volume of rice amassed from all households. There is also some barter with neighboring mestizo farmers, but this type of exchange is not as important. As will be discussed later,

Tsimane' interact with nearby farmers more for wage labor opportunities than for exchange of goods.

Jatata trade on the upper Maniqui River

River traders transport commercial items upriver to trade for some Tsimane' crops and animals, but mostly for *jatata* or cajtafa' palm panels. These traders act as intermediaries as they resell the panels at a higher price back in San Borja. In the more remote upriver communities such as Yaranda, traders come almost exclusively by motorized canoe, with only a few by punting. The site of exchange transactions for Tsimane' living in the Upper Maniqui is often the banks of the river or even up in the patios of their houses within their communities. Their terms of trade are structured through a credit-debt system. For the most part, residents of Yaranda are dependent on these traders to access consumer goods they have come to incorporate as necessities such as salt, sugar, ammunitions, and soap. Even though the unit prices are higher it would be more expensive for them to make the trip to San Borja for these goods.

The Tsimane' on the upper Maniqui River are principally integrated into the market economy through the gathering, preparing, and barter of *jatata* used for constructing thatch roofing panels. Both women and men walk long distances to gather the palm leaves from the forest. On return to the community, they weave the leaves and assemble panels for barter with traders or direct sale in the ports of San Borja or Yucumo with labor help from other household members. Tsimane' households produce roofing panels year-round with some decrease in demand in the wet season due to a combination of the humid climate unfavorable for drying and weaving and the lack of traders due to the high river levels. We recorded no *jatata* trade during Quarters 3 or 4 of our panel study, corresponding to January and April during the wet season. *Jatata* panels have been

traditionally used by the Tsimane' in the construction of roofs. In the lower Maniqui, where *jatata* does not grow, many families opt for *motacu* or Mana'i (*Attalea phalerata C.*) palm roofing, a substitute lower in quality and less durable.

The history of *jatata* production is demonstrative of the articulation of the Tsimane' people with the regional market – one of compulsory exploitation (Rioja 1992). Traders used alcohol to induce Tsimane' men into working for them in the *jatata* trade. In 1988 the Tsimane' signed an agreement with the River Traders' Association and San Borja municipal authority prohibiting the sale of alcohol by the traders. However, it still continues today. Other tactics used by traders include the brandishing of firearms and authoritarian tone of voice in communication with the Tsimane' (Añez 1992; Chicchón 1992). *Jatata* traders operate in a coercive mode reinforced by Tsimane' beliefs. If someone refuses a trader's demands and subsequently something bad happens within the family, the Tsimane' will attribute it to the power of the traders as they believe that traders are capable of bewitching. Sometimes, traders take on fictive kin roles as godparents to Tsimane' children. When debts accumulate, this familial obligation enables traders to oblige the Tsimane' to travel down river and pay their debts in jatata. The *jatata* trade is an interesting activity to analyze. On the one hand, distant communities benefit in that they are unable to make the long trip to town for necessities such as ammunition, clothing, batteries, kerosene, and fish hooks. Yet, the terms of trade result in a debt-payment cycle that is difficult to escape. Some Tsimane' show resistance to the exploitive terms of trade and opt to float the *jatata* down the river to market it. Often two to three male kin will pool their *jatata* panels and float down on a balsa raft to trade at a higher price. It is an arduous trip, but the cash payoff is usually higher price

per panel. Tsimane' reported getting as high as 3 Bs. per panel compared with the average price of 1.38 Bs. in the village.

The story of *jatata* trade continues with a new twist on one Tsimane' man's response to political and economic opportunity. Politically, there was a push from NGOs and the Gran Consejo Tsimane' to improve the terms of trade in upriver *jatata* exchange. While several efforts to circumvent intermediary river traders have been made, none have proven sustainable. After accumulating savings from work as a translator in our research project, one man took on the role of a *jatata* trader and has assumed the role of intermediary trading goods for *jatata* with Tsimane' living upriver and reselling in San Borja. His capitalist endeavor is looked upon from different perspectives. On the one hand, he is Tsimane' and therefore a more trusted actor in exchange relations, yet at the same time, it is well known that he is in it for individual financial gain (Reyes-García personal communication 8/8/2002). He continues this activity today and is accepted as he pays slightly higher per panel than the traders and does not trade alcohol (Reyes-García personal communication 8/9/2003).

Wage-Labor

Wage employment opportunities for the Tsimane' structured on a debt-peonage arrangement opened up with the 1950-1970 expansion of the cattle industry in the Beni (Piland 1991). Traditionally, alcohol was used to entice Tsimane' males into working for loggers or traders where their labor was exploited. As an example, the average price of a day of labor is 20-25 Bs, while the price of one liter of alcohol (often the daily payment) is only 5 Bs. This still occurs somewhat today, but there is more evidence of paid employment. While fewer opportunities exist due to the lower labor requirements of the industry, some Tsimane' work sporadically for logging companies. Logging and

ranching activities in the areas provide seasonal opportunities for wage employment. One of the most important sources of wage labor is in agriculture. During the planting season, many young males hire themselves out to cut and plant for large-scale farmers or colonists in the surrounding areas. During the study period, the average daily wage was 25 Bs. without lunch or 20 Bs. if lunch was provided mid-day to the laborers. There are no frequent wage labor opportunities for Tsimane' women. On rare occasion, young women work as domestic help in town but this is not a common activity nor reported during the economic surveys.

I found both qualitative and quantitative differences in wage labor activities when comparing the two communities. Men in San Antonio reported more days working in wage labor as well as a broader range of activities over the course of the panel study as portrayed in Table 3-3. This is in part dictated by the location of the communities. The neighboring small farmers and ranches in the lower Maniqui are significant sources of wage employment. Wage work in agriculture was the most frequent type of work in San Antonio (303 days; 37%) followed by cattle ranching (164 days; 20%). By comparison, there are only 8.5 days (1%) of agricultural day labor reported from men in Yaranda. Table 3-3 also shows differences in employment of teachers in Yaranda. Over half of all days worked in wage labor in Yaranda are accounted for by the three full-time teachers. If we omit wage labor days of the teachers, San Antonio would have more than twice the number of wage labor days as Yaranda (684 vs. 286 days). This disparity holds true if we take out the effect of employment as translators, general labor, and plant collection generated directly by our research study. This comparison begins to differentiate the livelihood strategies of some households in San Antonio compared with Yaranda. Work

for logging companies and with traders in *jatata* extraction are the only two significant sources of wage work in Yaranda.

Table 3-3. Total days of wage labor recorded during income surveys by type of activity and community

	San Antonio		Yaranda	
Wage labor Activity	n	%	n	%
Teacher	124	15%	308	52%
Panel Research Study	82	10%	133	23%
Agriculture	303	37%	8.5	1%
Cattle Ranching	164	20%	0	0%
Gran Consejo Tsimane'	60	7%	0	0%
NGOs	29	4%	0	0%
Logging Industry	28	3%	26.5	4%
Unknown type	12	1%	0	0%
Transport	7	1%	0	0%
Religious Organization	0	0%	10	2%
Jatata Trade	0	0%	108	18%
Total	809	100%	594	100%
Total, omitting teachers	685		286	
Total, omitting labor generated by research study	727		461	

Chapter Summary

The Tsimane' resisted early attempts by missionaries to convert them to Christianity, an important factor in their relatively low level of acculturation until the twentieth century. In recent times, acculturating forces from new evangelical groups and the expanding regional economy have had more profound effects on brining the Tsimane' into contact with elements of national culture. The different forces described in this chapter have affected their social and political organization, resulting in more social stratification and distinct positions of political leadership. In the following chapter (4), I address the economic aspects of acculturation and integration into the market economy, comparing individual, household, and community-level differences.

CHAPTER 4
TSIMANE' ACCULTURATION AND MARKET INTEGRATION: THE CASE STUDY OF SAN ANTONIO AND YARANDA

Introduction

The history of the Tsimane' in the twentieth and twenty-first centuries is a history of increasing integration into the wider economy and Bolivian national society. Economically, the Tsimane' have established increasing links and interdependencies with the larger regional and national economies. Socially, Tsimane' behaviors and customs have been influenced by the dominant culture of Bolivian mestizo society. Many of the significant historical and political forces shaping Tsimane' culture and economy were discussed in Chapter 3. According to Chicchón (1989) there has not been as great an impact from the evangelization on Tsimane' culture as from the acculturation by economic forces.

Despite the increasing influences of contact and integration, there is great variation in acculturation and economic integration within the Tsimane' population. This path toward greater social acculturation and economic integration has different routes. There is no single response to the multiple stimuli generated through contact with the wider Bolivian society. A comparison of both mode and degree of acculturation and integration into the market economy between the two study communities, San Antonio and Yaranda, exemplifies this phenomenon. Location of a community is one important element shaping exposure and contact to exogenous cultural systems. Proximity to the market town influences the types of exchange relations with non-Tsimane'. But village distance

from a market center does not entirely explain variation in economic activities or social behaviors. Within each community, our teams observed great variation both in degree of economic integration and social acculturation. As such, demographic characteristics, individual measures of human capital, and unobserved personal attributes must play significant roles. Each of these factors plays out differently at the individual, household, and community-level.

The objective of this chapter is to introduce, describe, and compare the measures of acculturation and economic integration that will serve as the explanatory variables in my analysis of Tsimane' health status in the remainder of the dissertation. I use descriptive analysis to unwrap the complexity of social and economic acculturation. I begin by describing demographic attributes of the communities and households. I then provide a discussion of the descriptive analysis of measures of acculturation, setting the framework for comparative analysis. I move on to discuss the different modes of contact and articulation with the market found in the two communities. Next, I describe specific economic activities of the Tsimane' in the market economy. From there, I present the descriptive analysis of individual-level measures of market integration relying on data from the quarterly economic surveys. Finally, I provide a discussion of household-level measures of market integration. This chapter sets the stage for the three subsequent data analysis chapters where I examine specific health outcomes as related to measures of acculturation and economic integration.

Demographic Attributes of The Sample (Control Variables)

Explanatory Variables

The main explanatory variables to be used in the analysis of Tsimane' acculturation, integration into the market, and various measures of health are defined in

Table 4-1. Before presenting and discussing summary statistics of the explanatory variables, I provide a brief descriptive analysis of the control variables or demographic characteristics of the sample on which these results are based.

Community Access

A dirt road from San Borja to the farming community of Santa Elena facilitates motorized transport year-round to San Antonio, with transport is less frequent in the height of the rainy season from November to March. Beyond Santa Elena, the road narrows to a wide walking path by which, depending on the weather conditions, San Antonio can be reached by small four-wheel drive vehicles. Access by motorcycle or motor scooter is possible year-round and several motorcycles pass through either side of the community daily. The residents of San Antonio do not regularly maintain the path nor are they particularly interested in making their community accessible to four-wheel vehicles, despite the recommendation by neighboring non-Tsimane' farmers with land interests down river. The majority of the residents travel in and out of the community by foot, although those who own bicycles use them to shorten the trip. Movement from one side of the river to another is accomplished year-round by punting dugout canoes, although there are some days in the wet season when the river-level renders the trip too hazardous. This relatively easy access to San Antonio is a key factor to the high degree of contact with the wider Bolivian society through such activities as development interventions, health prevention programs, academic research, and political participation.

Yaranda is more remote and difficult to reach. Because of the snake-like curving of the Maniqui River, it is faster to use a combination of land and river transport to access the communities on the upper Maniqui River than to travel the entire trip by water. The most direct route involves taking a truck for one hour and a half out of San Borja along

Table 4-1. Definition and measurement of explanatory variables in panel study

Variable	Definition
Measures of Acculturation	
Spanish	Ability to speak national language
Literacy	Ability to read national language
Education	Highest school grade completed
Math Skills	Level of mathematical ability
Measures of Integration to the Market	
Type of Income	
Cash Income	Individual income earned in cash in the last 30 days
In-kind Income	Individual income earned in-kind in the last 30 days
Consumption	Imputed value of farm and forest goods entering the household in one day
Source of Income	
Wage	Individual income earned through wage labor in the last 30 days
Sale	Individual income earned through sale or barter of agricultural or forest products in the last 30 days
Gift	Individual income earned from gifts or remittances in the last 30 days
Wealth	
Modern Wealth	Value of 18 market derived material assets
Traditional Wealth	Value of 4 traditionally produced material assets
Control Measures- Demographic Attributes	
Community	(1 = San Antonio, 0 = Yaranda) Dummy for residence
Household Size	Number of individuals living in household
Subject ID	Unique Subject Id
Age	Age of subject in years
Age^2	Square of age of subject in years
Female	(Female = 1; Male = 0) Dummy for sex of subject
Quarter	(1-5) Time variable for Quarter of data collection
Mean Rainfall	Average daily rainfall per quarter in each community (mm)

the dirt highway leading to Yucumo and La Paz. There are several suitable river ports where dugout canoes can land at a distance of anywhere from 20 to 45 minutes by foot from the highway. By dugout canoe with an outboard motor, the trip upriver can take an average of five to seven hours when river levels are favorable. During the wet season,

river transport upriver is slower due to the strong counter currents and dangerous amounts of debris in the river. The dry season poses a different type of challenge for river transport between San Borja and the upper Maniqui as water levels can drop so low that sandbars litter the riverbed. The trip down the river from Yaranda to the ports can take anywhere from four to six hours. Without the luxury of an outboard motor, the upriver trip can take two weeks and the descent three days by punting smaller dugout canoes. Seasonally, there has been a logging road used by SATA enterprises but is dependent on their logging activities and is privately operated.

Household and Individual Demographic Attributes

Our sample of individuals comes from the two communities of San Antonio and Yaranda. In this section, I highlight the differences in household and individual attributes of the sample. Summary statistics on demographic attributes of the panel sample are presented in Table 4-2. Each variable is disaggregated by sex and community to provide a comprehensive picture of how acculturation and integration vary throughout our sample.

Household composition

The 332 individuals in the study constitute 51 households in two communities. When comparing communities, there are notable differences in household formation and composition. In San Antonio, there are six households formed around interethnic marriages between a Tsimane' and a non-Tsimane' spouse. It was more common for the non-Tsimane' spouse to be female (four were females). Four are native Spanish-speaking lowlanders from small population centers in the Beni, and two are of the closely related Yuracaré ethnic group. The Yuracaré descendents have all learned to speak

Tsimane' fluently, but there are varied levels of language comprehension among the nonindigenous spouses. There are no exogamous marriages in Yaranda.

Table 4-2. Demographic characteristics of the sample by community

Variable	San Antonio	Yaranda	Total	t	P <|t|
HOUSEHOLDS					
Households in Study					
Number	27	24	51		
Mean Composition (SD)					
Household Size	5.9 (2.7)	6.0 (3.1)	5.9 (2.8)	0.33	0.73
ADULTS					
Sample *(age ≥ 15 yrs)*					
Women	41	32	73		
Men	43	34	77		
All Adults	84	66	150		
Mean Age (SD)					
Women	32 (13.9)	37 (16.5)	34 (15.2)	1.09	0.27
Men	33 (13.7)	35 (15.8)	34 (14.7)	0.65	0.51
All Adults	33 (13.9)	36 (16.2)	34 (15.0)	1.25	0.21
CHILDREN					
Sample *(age <15 yrs)*					
Girls	52	35	87		
Boys	53	42	95		
All Children	105	77	182		
Mean Age					
Girls	6.2 (4.1)	4.8 (4.0)	5.7 (4.1)	-1.58	0.12
Boys	5.8 (4.2)	6.8 (4.0)	6.3 (4.2)	0.18	0.24
All Children	6.0 (4.1)	5.9 (4.1)	6.0 (4.1)	-0.17	0.86

There are more households in the sample from San Antonio (n = 27), but Yaranda (n = 24) is made up of more extended families. The population of Yaranda is comprised principally of two main genealogical branches. In San Antonio, there are fewer close kin ties between households. The average household size of six individuals was similar in both communities over the five quarters with a range of one to fourteen. Within each household, size and composition can vary from quarter to quarter because of the custom of long-term visits to relatives in other communities or long-term wage employment.

Age and sex distribution

For the present analysis of demographic variables, I treated anyone 15 years or older as an adult based on the importance of their economic activities and demographic attributes. In both communities there were women as young as 15 years old who were married with children at the start of the panel study. Their human-capital attributes are significant, as they will be analyzed as the parents of children in the assessment of child health status. At the same time to use only married adults would exclude a large number of single economically active household members in the 15-25 year age range.

Average age by sex for adults and children is displayed in Table 4-2. Age differences between the two communities are not significant among either adults or children. There are a total of 150 adults in the survey, 84 from San Antonio and 66 from Yaranda. The average age for adults is 34. The total sample of children (age<15 years) is 182, with 105 in San Antonio and 77 in Yaranda. The average age is 5.8 years for girls (SD = 4.1) and 6.3 for boys (SD = 4.2).

Measures and Discussion of Acculturation

The process of acculturation into the values and practices of another group implies interaction. Individual differences in measures of acculturation influence economic integration and therefore need to be controlled for in the statistical analysis presented in the following chapters. For example, a person's ability to communicate in the national language facilitates interactions and exchange in the market economy. To assess levels of acculturation among the Tsimane', it is useful to look at social behaviors and customs to examine how they have been influenced by the wider Bolivian society. More frequent and intense exposure to Bolivian social norms and behaviors in communities closer to any of the market centers is expected. Whether or not this exposure leads to the adoption,

integration, or rejection of social values and behaviors is worth understanding. A portrait of Tsimane' interactions with non-Tsimane' actors is presented in this section with summary statistics from the measures of acculturation we used in this study. Table 4-3 presents summary statistics on individual-level measures of acculturation for adults in both communities and for the pooled sample. I tested all of the measures of acculturation for statistically significant differences between communities (Chi^2 or T-tests) and the significance levels are reported in the table.

Educational System

Each of the communities has a one room schoolhouse where a male Tsimane' professor teaches kindergarten through fifth grade. In Yaranda, the teacher has an assistant, while in San Antonio the responsibility of instruction of all ages and grades falls on one individual. A subjective assessment of the quality of the education by our research team places Yaranda above San Antonio primarily because there are more consecutive days of teaching and therefore more consistency to the course of study. This contradicted our initial expectations that the more market-integrated community would value education more. Compared with the teacher in Yaranda, the teacher in San Antonio does not demonstrate as strong a commitment to the community, perhaps because it is not his community of origin and he does not have any immediate relatives there. There are also more routine distractions and occasions for the teacher in San Antonio to skip work and go into San Borja. Coincidentally, Yaranda is home to a disproportionate number of additional trained teachers (six) who work in the schools in the neighboring communities of Cosincho (2), Santa Maria (2), Cachuela (1), and Navidad del Maniqui (1).

Table 4-3. Summary of adult measures of acculturation

	San Antonio		Yaranda		Total		Between Community	
	n	%	n	%	n	%	Chi^2	P
Some Spoken Spanish								
Women	27	66%	12	38%	39	54%	5.2	0.02
Men	38	88%	26	76%	64	83%	1.9	0.16
Total	65	77%	37	56%	102	68%	7.7	0.01
Literacy in Spanish								
Women	5	12%	8	26%	13	18%	2.2	0.14
Men	19	45%	17	50%	36	47%	0.2	0.68
Total	24	29%	24	37%	48	32%	0.9	0.33
Highest Math Ability								
Women							8.9	0.06
None (0)	30	73%	18	58%	48	67%		
Addition (1)	5	12%	9	29%	14	19%		
Subtraction (2)	0	0%	2	6.5%	2	3%		
Multiplication (3)	4	10%	0	0%	4	5%		
Division (4)	2	5%	2	6.5%	4	5%		
Average	*0.61*		*0.68*		*0.64*			
Men							6.8	0.15
None (0)	20	47%	11	32%	31	40%		
Addition (1)	6	14%	8	24%	14	18%		
Subtraction (2)	7	16%	4	9%	10	13%		
Multiplication (3)	4	9%	1	3%	5	7%		
Division (4)	6	14%	11	32%	17	22%		
Average	*1.3*		*1.8*		*1.5*			
Highest School Grade	Mean	(SD)	Mean	(SD)	Mean	(SD)	t-test	P
Women	0.97	(1.46)	1.46	(1.76)	1.19	(1.60)	1.3	0.19
Men	1.92	(2.66)	2.65	(2.53)	2.25	(2.61)	1.9	0.23
Total	1.46	(2.18)	2.11	(2.26)	1.74	(2.23)	1.8	0.08

A prominent source of acculturative influence in San Antonio comes from the technical assistant assigned to the community by the Bolivian Ministry of Education. In addition to the coordination and supervision of teachers, she has promoted the celebration of national holidays such as Mother's Day, Father's Day, Bolivian Independence Day and attempted, though unsuccessfully, to organize a *reina* (queen of the school) competition common throughout Latin America. She also contributes to and participates in the annual

community festival for the Feast of San Antonio beginning on June 14. The three-day festivities draw neighboring farmers, towns people, and Tsimane' to San Antonio for a soccer tournament, meal, and copious *chicha* and alcohol consumption. Outsiders arrive much less often to Yaranda and they do not regularly celebrate national holidays. Their community festival on March 19, the Feast of San José de Yaranda, is a much smaller affair involving only neighboring Tsimane' communities. The technical assistant to the teacher makes infrequent visits and does not participate in the festival.

Fluency in Spanish

Our team evaluated Spanish fluency during the preliminary research phase by assigning each individual a score based on the researcher's subjective evaluation.[10] We changed scores over the year, as we were better able to evaluate people's ability to communicate in Spanish after residing some time in the two communities. For my analysis, I collapsed the score for Spanish oral fluency into a binary variable of whether or not the subject could communicate orally with us and understand some Spanish orally (0 = speaks no Spanish; 1 = some understanding to fluent).

I also examined language ability disaggregated by gender. There are notably more bilingual men (83%) than women (54%) in both communities. Men have more interaction with Spanish speakers and higher levels of formal education on the whole. In Yaranda, only 38% of the women were able to communicate in Spanish compared with 66% in San Antonio ($Chi^2 = 5.23$; $P = 0.02$). Among adult men, 76% in Yaranda and 88% in San Antonio are capable of speaking Spanish. Male differences in Spanish ability are not statistically significant. Overall, adult differences in fluency in Spanish between

[10] All researchers were either native Spanish speakers or fluent non-natives.

communities are significant ($Chi^2 = 7.7$; $P<0.001$). While we employed translators to work with us in collecting data in both communities, when necessary, communication with residents in Spanish was more feasible in San Antonio. Communication with the assistance of a translator was necessary at all times in Yaranda. All six of the interethnic households in San Antonio report that their children have learned Spanish as their first and primary language of communication. Despite living in a Tsimane' community, the children communicate within the household in Spanish and with other children in Spanish more often than in Tsimane'.

Literacy in Spanish

Because I am interested in measures of acculturation into the dominant Bolivian culture, I analyzed literacy in Spanish rather than in Tsimane'. The Tsimane' language is not often written in daily activities. Literacy was defined as the ability to read a simple sentence off an index card in Spanish. We administered tests to all subjects during the baseline survey by showing them one of a series of simple sentences written in Spanish. We assigned the following scores to each subject: "0" = can't read it at all, "1"= can read it with difficulty, or "2" = can read it with ease. If an individual told us they could not read, they were automatically assigned a "0" and were not tested. I collapsed the three point score for literacy into a binary variable (0 = could not read at all; 1 = could read (with difficulty or ease)) of being able to read or not for this analysis.

Spanish literacy rates are significantly lower for women than for men in both communities ($Chi^2 = 16.4$; $P<0.001$). Only 18% of all women in the sample demonstrated literacy in Spanish, compared with 47% of men. However, when comparing literacy by sex between communities, differences are not significant (Table 4-3). There are similar percentages of men who can read in Spanish in the two

communities (San Antonio 45%, Yaranda 50%; $Chi^2 = 0.2$; $P = 0.68$). The finding that half of the adult male population in Yaranda showed some skill in literacy in Spanish is higher than we would have expected, as adults have generally not had many years of education. We anticipated these skills to be less developed in the more remote community. The disproportionate number of trained teachers in Yaranda probably accounts for this high rate of literacy among men. There is another unexpected finding of more women in Yaranda (26%) who can read than in San Antonio (12%). However, it is not statistically significant ($Chi^2 = 2.2$; $P = 0.14$), and in real terms is a difference of only three women and may reflect greater exposure to formal education through presence of the teachers.

Highest School Grade

We asked subjects to tell us the highest grade in school they had completed. No woman in either community reported studying beyond fifth grade.[11] Only six men had studied beyond fifth grade in the combined sample. Two of these are young men from San Antonio who had scholarships to study in a technical program in the departmental capital of Trinidad. They were present for the study in two of the five quarters. There is no education offered beyond fifth grade in either community. To study past fifth grade, students must enroll full-time in schools in San Borja or attend an alternative certification programs. The data were heavily zero-censored and 55% ($n = 40$) of all the women in the sample had no formal schooling. The average highest grade for women was less than second grade (mean = 1.19). Men had an average highest grade of less than third grade.

[11] However, during the research period, one woman, the wife of the teacher in San Antonio, completed the high school diploma program along with the other 29 Tsimane' adults. She participated in a compressed study program in which adult students studied one week a month through an alternative certification program in San Borja. It is unclear why she did not report a higher grade at the time of the baseline survey.

The median grade level for all groups was below first grade (no schooling) except for men in Yaranda where it was second grade (2.5 grades). Again, the teachers in Yaranda are pulling the median measures of educational achievement up, something that we were unaware of during the selection of the communities. There were no significant differences in mean highest school grade when comparing women or men from San Antonio with corresponding women and men in Yaranda. Differences in educational achievement are more significant between men and women overall ($t = 2.9$; $P<0.001$; not shown) than for all adults between communities ($t = 1.8$; $P = 0.08$). Men have studied one additional grade on average when compared to women.

Mathematic Ability

To assess individual ability at mathematics, we asked each adult whether they could add, subtract, multiply, and divide. Next, we asked them to orally complete simple math problems of each skill stopping at the highest skill at which they failed. We intended to assess human-capital skills important to acculturation with this simple test. I recognize that the results of this test do not necessarily indicate that Tsimane' adults are not capable of adding and estimating quantities. In part, it reflects familiarity and comfort with these types of examinations. There is a wide gap in mathematic ability between women and men in the combined sample (not shown). Men were more competent in the more advanced math skills ($Chi^2 = 17.0$; $P<0.001$; not shown). Over half of all women (67%) were unable to complete the simple addition problem on the card. Only 13% of all women in the sample had mathematic skills beyond addition, compared with 42% of all men from the pooled sample. When comparing the differences between the two communities, mp significant difference was detected among men and only slight difference among women ($Chi^2 = 8.9$; $P<0.06$).

Comments on Measures of Acculturation

The above analysis shows that women have consistently lower measures of acculturation into the formal educational system than men. Women's education is consistently found to be an important predictor of child health status in the developing world (Akin et al. 1985; Caldwell 1993; Phillips 1990). However, in low-income sectors, there may not be enough variation in mother's schooling to make a difference in child health (Kennedy 1994). Compared to men, women in both communities are presumably less able to communicate effectively outside of their native language, they have less contact, and are more reluctant to interact with non-Tsimane' than men.

Exposure and competency in Spanish language and mathematical skills for adults can be a product of training opportunities through employment and NGO workshops to which males exclusively attend. For example, members of the Gran Consejo Tsimane' and their extended families are far and above the most acculturated segment of the Tsimane' population. The majority of the Consejo have taken up residence in or around the town of San Borja, and no longer farm or hunt. They are the core of the Tsimane' elite and are followed closely in order of status by the cadre of bilingual teachers who have benefited most from educational opportunities and development projects. The teachers represent a higher degree of acculturation and integration to the market economy as well, in that they are capable of living off only their wage income without having to engage in traditional modes of subsistence. In San Antonio, the teacher is from another community and does not plant a field. Instead, he collects his monthly salary through the education department and he and his family live off the food subsidies provided by the parents of the school children. In Yaranda, the teacher is a resident of the community, so his case is somewhat different in that his family might plant a field but does not collect

and trade *jatata* thatch panels like the other residents. Nevertheless, he is the wealthiest individual in the entire sample. His training as a teacher and role as a representative of the community have provided him with distinct opportunities for financial gain and wealth accumulation.

Differences in acculturative influence are also apparent at the community-level. When compared to the neighboring communities, it is evident that development interventions repeatedly arrive in San Antonio rather than to other Tsimane' communities due to ease of access. The Gran Consejo Tsimane' repeatedly recommends San Antonio for small studies by universities, visits by donors, diffusion of new technology, or the very infrequent tourism requests. There is a strong relationship between the Estación Biológica del Beni (EBB) park guards and the residents of San Antonio. Although San Antonio does not lie within the limits of the EBB Reserve, it is considered within the zone of influence and community representatives are included in training courses and management meetings.

Unfortunately, the Tsimane', particularly in San Antonio, have a history of contact with development agencies and government institutions which arrive with promises of water projects, assistance with healthcare, agricultural technology, and marketing training that have consistently failed and been abandoned by the organization. During the first three months of our study several potential works projects arrived in San Antonio, none of which came to fruition. This pattern of contact and promises for whatever underlying reason (fiscal insecurity, political change, poor planning, etc.) has led to a mistrust and apathy among community members and leaders toward any future projects. As a consequence, any new project has to deal with this every time they work in a new

community. This is a common legacy that failed development has on the indigenous people in Bolivia and around the world. In Yaranda, there was a weaker presence of development projects. During the study there were only two projects, a jatata store which failed after three to four months and a new school that was completed after a year. Residents of Yaranda are not as disillusioned or skeptical about projects as residents of San Antonio.

Tsimane' Articulation With The Wider Economy And Society

The focus now shifts to different aspects of Tsimane' integration to the market economy, beginning first with a general discussion, and then moving to specific measures. A discussion of Tsimane' integration into the market economy must begin with a portrait of the market system and locale specific to their case.

San Borja and the Regional Market

The town of San Borja is an important economic and political link between the cities of Trinidad and La Paz. These two cities are linked by daily road transport through San Borja and several times a week by air. San Borja is the main source of commercial products for the Tsimane' living on the Maniqui River and in the Multiethnic Territory. The town of Yucumo, to a lesser extent, is a source for basic necessities in the surrounding areas, but does not compare in scale to San Borja.

San Borja serves as regional market for peasant populations, town residents, and native groups such as the Tsimane'. The market configuration consists of formally established stores, street vendors, market stalls, and ambulant traders. A dynamic set of cultures is represented among San Borja's population. Within town, there are marked economic activities between the Bolivian lowlanders (*cambas*) and highlanders of Andean Aymara and Quechua descent (*collas*). Cattle ranching is the traditional

dominion of the lowland elite who employ lower-class *cambas* as ranch hands and laborers. In the past decades, many of these laborers have left the ranches to start their own small-scale farming activities. Logging is a second major economic activity for San Borja. The logging industry has both a strong economic and political presence in San Borja. In another economic sphere, migrants from the valley regions of Cochabamba or highland Departments of La Paz and Oruro manage food markets and small retail businesses. Cultural comparisons are often made between the keen work ethic and conservative fiscal ideals of *collas* in contrast with the laidback *cambas*. Today, influential political positions are held by lowland elites, but the commerce continues to expand under the management of highland colonists. Residents of San Borja are more likely to have some familiarity with San Antonio than of the more remote communities on the upper Maniqui. Likewise, residents of San Antonio generally have greater and more frequent contact with non-Tsimane'.

San Borja is also the social, commercial, and economic center for the Tsimane' people outside of their communities (Chicchón 1989). In town, the Tsimane' access biomedical health services, advanced educational training, and conduct administrative affairs to variable extents. Several key organizations and political institutions are located in or around San Borja. The offices of the Gran Consejo Tsimane' and EBB are within town limits. For communities within the reserve's area of influence such as San Antonio, it is a frequent place to go to discuss land conflicts and encroachment problems. As discussed previously, the New Tribes mission also has it local headquarters (Horeb) on the outskirts. Educational opportunities, teacher training, and religious seminars all draw the Tsimane' to Horeb. This high potential for interaction with Bolivian society

influences acculturation. Many of these activities and contacts are facilitated through some functional competency in Spanish. Residents of nearby communities have more frequent interaction with these services and institutions. These opportunities disproportionately involve males going into town for courses or errands.

Tsimane' as Participants in the Market Economy

Within San Borja's market system, the Tsimane' play the dual role of consumer and producer. As producers and sellers, the Tsimane' occupy a highly marginalized position. Consistent with other Andean countries, as natives of the Amazonian region the Tsimane' are marginalized by the national society. Bolivia is notable for the high percentage of citizens of Amerindian origin (56%), yet racial discrimination is rampant as the dominating upper class claims European origin or admixture. Due to weaker social networks with townspeople and limited cash resources, it is more costly and difficult for Tsimane' to organize transport of their goods into town. Consequently, the prominent image of the Tsimane' in commercial activity involves them lugging their wares on their backs along the dusty roads into San Borja. Attitudes by town residents toward the native groups are discriminatory, exploitive, and paternalistic. On frequent trips out to the community, motorcycle-taxi drivers would convey to me their biased opinions of the Tsimane' as poor, lazy, inferior, and even drunk, often repeating stereotypical comments about their behaviors, especially child rearing and food preferences. Yet during the annual festival to celebrate the founding of San Borja, urban residents participate in parades highlighting folkloric representations of the native groups in the Beni, including the Tsimane', through costumes depicting native dress during the colonial period. Only during these ritual events will they claim or allude to a heritage or connection with the native peoples of the Beni.

As consumers of manufactured goods the Tsimane' account for a demand of a certain repertoire of material goods. Regular purchased products include ammunitions, wool thread, fishhooks, batteries, used clothing, sugar, salt, soap, pharmaceuticals, and flashlights and alcohol. As clients to the service industries, the Tsimane' people generate a variable demand for health care, educational services, and administrative dealings in town. The demand for health services at the hospital has not shaped the service orientation in favor of the Tsimane'. Tsimane' patients are treated poorly and we observed almost no cultural sensitivity on the part of the nurses and doctors. As a result, some Tsimane' are more trusting of the owners of the pharmacies than of the health care providers with medical training, despite the greater profit motives of the pharmacy owners and the risk of economic exploitation. Others prefer to go to Horeb where they are treated better and other Tsimane' there can usually help them communicate with the nurse.

Wealth Accumulation

The accumulation of material wealth can be linked to participation in economic activities. We observed greater intensity of rice production directed toward sale in the market economy in the more integrated community, much of which was motivated by desire to acquire manufactured items and staples that the Tsimane' have come to perceive as needs, such as sugar, soap, white flour, noodles, and cooking oil. What was once a "luxury is now a necessity" (Gross et al. 1979; Murphy and Steward 1968[1956]). A small exploratory study on product preference revealed patterns in preferences for market-acquired substitutes for a series of assets common to Tsimane' livelihood with closer proximity to the market town (Lieberman 2000). A prime example are the large plastic trashcans that many Tsimane' women desire to store the traditional *chicha* or

manioc beer. Traditionally, men carved *gabetas* or wooden troughs for the preparation. It is now prestigious in the more integrated community of San Antonio to have a plastic product. There also appears to be a trend in preference for modern substitutes among younger generations.

The Tsimane' do not store or save income in the form of cash. Rather, we observed the immediate disposal of cash income. Even with the relatively large lump sum payments from wage work or large rice or plantain sales, ethnographic evidence from the two-community panel study indicates that cash is not often brought back to the community, but rather, spent while in the market town or soon after its receipt. There is a marked pattern of behavior among young males who earn cash through wage labor activities that suggests that the Tsimane' are becoming more acculturated to the desire and value of commercial products available through markets. Their income is largely directed toward the accumulation of market-derived items such as bicycles, radios, watches, new clothing, and firearms, behavior that is not observed to such a large extent among other segments of the Tsimane' population. The importance of these newly acquired material objects lies in the status that it imparts on the owner rather than the use value. One clear example is the use of a wristwatch by young men. Tsimane' daily activities are not structured according to Western timing; rather, different positions of the sun indicate noontime or the end of the workday. Ownership of a watch is a signifier of having gone into the white world and successfully earned the resources to acquire the wealth item (Rioja Ballivián 1996).

Everyone in the community is aware when a significant material asset is acquired by another resident. On occasion theft or loss of assets such as metal tools from

household was reported, yet as a general rule there were no obvious preventative measures such as safeguarding of assets inside the house. Further, there is no ample evidence of maintenance of wealth items accumulated, perhaps implying that wealth accumulation functions more for short-term prestige than long-term investment in elevation of social status or stock economic assets.

Credit Markets

There do not exist any formal credit institutions within Tsimane' society, nor are the Tsimane' people integrated into the regional or national banking systems. Informally, relatives lend seed and surplus products to one another, but the borrowing and lending of cash is not common, even in times of shock. Households reported borrowing credit as a way to cope with shocks in only 3% of the surveys. In part, this can be attributed to the infrequent availability of cash reserves; most cash income is spent soon after its receipt. This behavior is consistent with other findings that former subsistence-level populations will not incorporate cash into norms of generalized reciprocity (Burkhalter and Murphy 1989; Reed 1995). Yet at the same time, credit-debt relations are the principal organizing factors to the *jatata* trade. Tsimane' individuals who have worked for towns people or ranchers will often draw on ritual kinship ties or *compadrazgo* to borrow or seek out donations in times of shock. Used clothing is one commodity which is given by townspeople familiar to individual Tsimane'. The Horeb health clinic will extend credit in labor for services rendered.

Accessing the Market in San Borja

The experience of getting to the market is dissimilar for residents of Yaranda and San Antonio. In contrast to Yaranda, there is year-round access between San Antonio and San Borja by foot. It is more difficult and time-consuming during the rainy season,

but Tsimane' living downriver from San Borja do not experience periods of isolation from town as is the case with upriver communities.

San Antonio

During a typical trip to San Borja, residents of San Antonio set off toward town on foot in the early morning hours to avoid the heat. They carry their goods in woven bags with the help of other family members. Women travel in groups with other women and/or children and sometimes with their spouses; men go alone or in groups. Teenage boys often share a bike to make their way to the market. On rare occasions, some of the males will pool together to rent a vehicle and driver to transport a large quantity of plantains or rice, or even prearrange to meet a buyer at the port at Santa Elena. By foot the trip into San Borja ranges from three to four hours walk, depending on the weight of the load and the make-up of the group. By bicycle the time is cut to about and hour and a half. Once at the outskirts of the town, they head toward neighborhoods where they might have had luck previously selling their wares or to the more popular streets for marketing. After successfully peddling a few items, they will make the purchases they came for and linger around the market area.

Although transaction costs may seem low when compared to a more distant and less accessible community, they are high compared with returns to their investments. For instance, the sale of eight bunches of plantains, weighing between 20 and 25 kilograms, will only earn 8 Bs. Unless a bike or truck is used, it takes a full day to get to market and back. By comparison, a day of wage work pays an average of 20 Bs.[12] However, wage labor opportunities are not always predictable or available on short-notice as will be

[12] Bs. = Pesos Bolivianos; Average exchange rate during 5 quarters of study was 6 Bs. ≈ U.S. $1.

discussed in a later section. The difference is that sale in the market is a constant option and demand for cash can be easily met by residents of communities close to town. For example, when school or community events require a cash contribution from each household, the quota is easily met by traveling to town to sell something. Even so, there are families in San Antonio who do not market their agricultural products in San Borja explaining that it is more beneficial to eat their own rice than to have to buy it later in the season when they face shortfalls and the prices are higher.

Yaranda

For the residents of Yaranda and other communities far upriver, San Borja is a more distant, costly, and removed marketplace. Some of the elderly residents have never been to the town. The time and monetary investments required for a trip to San Borja are considerable. The two principal options are catching a ride on a motorized dugout canoe to one of the closer ports or punting a smaller canoe all the way down to the port in San Borja. Sometimes they go by foot, but not when the purpose is trade or sale. If a canoe is unavailable through ownership or borrowing, balsa log rafts are constructed with the intention of a one-way trip. Floating a balsa raft is more difficult to maneuver yet can provide a large surface for transporting goods such as *jatata* panels. Once in San Borja, Tsimane' from the upper Maniqui typically do not have any place to spend the night or enough money to purchase meals making the trip a hardship (Chicchón 1989). Unlike residents of San Antonio, Tsimane' from Yaranda will sell their goods to intermediaries in the ports rather than directly to consumers in town. Because of the large investment of time, Tsimane' from Yaranda and other upriver communities will spend several days to weeks away, visiting relatives along the way. During the field research, our team made monthly trips back and forth by motorized canoe owned and operated by the teacher in

Yaranda offering free trips to residents if necessary. There was not a high demand for this offer, suggesting that there are still additional costs or obstacles beyond transport such as labor to carry goods to the road rather than docking directly at the port in San Borja.

Measures of Integration To The Market

In this section, I move the discussion away from the more general context of Tsimane' articulation and integration with the regional market economy to specific findings from measures of market activity over five quarters of economic surveys. Income earned through exchange, sale, or wage work, wealth, and credit are used here as proxy measures for participation in the market economy. In a rural economy, consumption of goods via farm/forest production is also considered as a component of income.

Individual-Level Measures of Integration to the Market

I first present the descriptive statistical analysis of each of the measures of individual monthly income in cash or in-kind and material wealth for adults in the sample. After the presentation and discussion of individual measures, I address household-level measures of these same variables in addition to household-level consumption. While the economic surveys were conducted at the individual-level on all adults, we measured consumption at the household-level which lends itself to either per capita analysis or total household-level analysis, rather than individual adult measures.

Note on Statistical Analysis of Monthly Income

I disaggregated individual monthly income both by type of income earned (in cash or in-kind) and later by the economic activity through which that income was earned (wage labor, cash sales, barter, and remittances). Within the analysis of descriptive

statistics on each measure of income, it is evident that the sample generally violates the assumption of normality by equal variance between groups. Analysis of variance (ANOVA) and two sample t-test procedures for comparing the equality of means for income values between communities and genders are not robust to violation of sampling assumptions. I have reported the standard deviation (SD) of each measure to illustrate these violations. To address these problems, I additionally ran a nonparametric procedure using either the Kruskal-Wallis test which is not dependent on sampling assumptions or a t-test with an option for treating samples with unequal variance (Hamilton 1998). These are appropriate tests because there are also several outliers such as the teacher in Yaranda that may influence the analysis.

Total Monthly Income

Total monthly income was calculated for each adult by totaling their income (in cash and in-kind) from all sources reported in the economic surveys (Figure 4-1). While

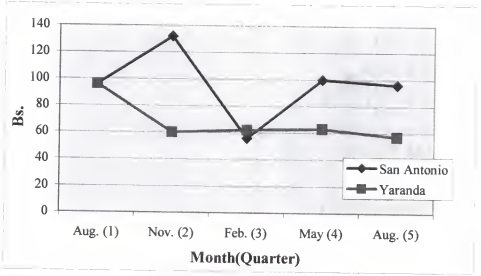

Figure 4-1. Total average monthly adult income by quarter

total average monthly income is lower each quarter for adults in Yaranda, it follows a more stable pattern over the five quarters. In contrast, adults in San Antonio show

greater fluctuations in average income with a marked peak and valley between Quarters 2 and 3. This pattern reflects the peak market activity from October (San Borja Fiesta) and lowest from January in the height of the rainy season and just prior to the rice harvest.

Figure 4-2 shows average monthly incomes disaggregated by both gender and community providing evidence that men's income is driving the pattern of average incomes in both communities. Women's income for both communities is relatively low.

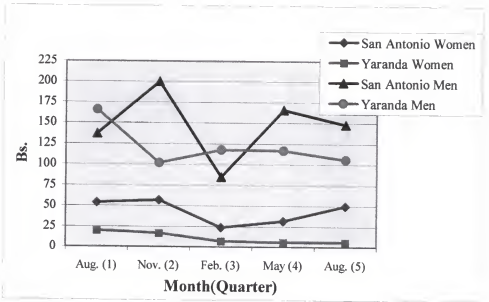

Figure 4-2. Total average monthly adult income by quarter and gender

Table 4-4 presents the gender and community disaggregated average incomes measured in all five quarters. Women in San Antonio reported more income than women in Yaranda both when looking at the mean and median values for the sample ($P < 0.0011$ for all 5 quarters). For Quarters 4 and 5, the mean income for women in Yaranda was 0 Bs. This informs us that total household income is not being heavily driven by remunerated economic activities of women in either community.

Table 4-4. Total adult monthly income in cash or kind by quarter (income rounded to nearest Bs[13]).

	San Antonio				Yaranda				Barttlet's Equal	Kruskal Wallis
Quarter	n	mean	median	SD	n	mean	median	SD	variance	P
Women										
1	29	54	20	61	29	20	4	37	no	0.03
2	32	57	29	66	30	17	4	27	no	0.01
3	33	24	17	25	30	7	7	7	no	0.03
4	31	32	13	57	27	6	0	19	no	<0.001
5	38	50	20	92	30	6	0	11	no	<0.001
Men										
1	30	137	48	209	31	166	56	328	no	0.03
2	35	200	91	293	31	102	49	161	no	0.01
3	37	85	55	104	29	118	20	219	no	0.03
4	32	166	90	196	29	117	16	288	no	<0.001
5	33	148	80	208	32	106	38	208	yes	<0.001
Total										
1	59	96	40	160	60	96	25	247	no	0.41
2	67	132	55	132	61	60	15	123	no	<0.001
3	70	56	33	83	59	62	8	162	no	0.01
4	63	100	30	159	56	63	2	213	no	<0.001
5	71	96	50	164	62	57	9	157	yes	<0.001

There are significant differences ($P<0.05$) between mean total monthly income for men in all five quarters, but the pattern of which community reported higher income changes. The higher income for men living in Yaranda in Quarter 1 is a probably a reflection of the wage labor income earned from building the house for our research team or trade in the community store active at the time. The drop in income for men in San Antonio during Quarter 3 mirrors the preharvest period when there is no rice to sell.

[13] The average exchange rate over the five study quarters was 6 Bs. ~U.S. $1.

Income by Type

The form in which income is earned may have different effects on nutritional status, dietary intake (von Braun et al. 1994), and even access to health services. Payment in cash is easily converted into other goods (e.g., medicines, food resources, luxury items, or alcohol) and services, whereas payment in-kind may be applied directly toward individual and household consumption. I disaggregated income by cash and in-kind earnings to compare the activity of barter and other payments in-kind with sales and wage employment usually paid in cash. The bulk of individual monthly income is earned in cash in both communities as shown in Table 4-5. Cash income accounts for an average of 58% of adult monthly income in the total sample. In San Antonio, an average of 71% of income is earned in cash compared with 44% in Yaranda. Income paid in-kind accounts for a smaller average proportion of individual monthly income in San Antonio (6%) than in Yaranda (22%). The median values demonstrate that over half of the population in San Antonio earns all their income in cash, whereas the proportion is much lower for Yaranda. The lack of a clear pattern by type of income in Yaranda signals wide variation in the composition of earnings among residents. Further, the relatively high cash salaries of the teachers pull the community average proportion from cash income upwards. These differences indicate community differences in type economic integration. Cash transactions are an integral part of the Tsimane' income in San Antonio, and less so in Yaranda. Payments in-kind have a more prominent role in Yaranda and probably in general on the upper Maniqui River than in San Antonio and other Tsimane' communities close to the market town.

Table 4-5. Characteristics of individual monthly income, average percent of total income earned by type

	San Antonio			Yaranda			Total		
	mean	median	SD	mean	median	SD	mean	median	SD
Type of Income									
Cash Income	71%	100%	0.44	44%	11%	0.47	58%	100%	0.47
In-kind Income	6%	0%	0.21	22%	0%	0.39	13%	0%	0.31

Cash income

Several observations can be made about monthly cash income regarding both gender and community differences displayed in Table 4-6. Women reported significantly lower income earned in cash than men for all of the quarters of study. Women in Yaranda earned significantly less cash income than women in San Antonio ($P<0.05$ for each of 5 quarters). The median income for women in Yaranda was zero in three quarters and of insignificant amounts in the other two. The results reveal that over half of the women are not earning any cash income. This is not surprising given the market configuration, levels of acculturation, distance, and economic activities of Tsimane' on the upper Maniqui River. While there are higher average and median monthly incomes for women in San Antonio, at the same time there is greater variance in monthly cash income for women in San Antonio. This suggests that not all of the women in the more integrated community are involved in cash income generating activities.

Among men, average monthly cash income is higher in San Antonio for all quarters except Quarter 3 ($P<0.03$). Figure 4-3 graphically shows quarterly fluctuations in income by each group. Large seasonal fluctuations are notable for men in San Antonio. Recalling back to the annual calendar (Figure 3-2), income from Quarter 3 corresponds to earnings during January, the heart of the wet season, when mobility is most restricted and prior to the rice harvest. There is less opportunity for wage work and sales of agricultural

or forest products during this time. Men's cash income in Yaranda is highest in the months when there is no *jatata* trade which is primarily exchanged through barter rather than for cash. There may be a conscious shift to cash earning activities during this time.

Table 4-6. Individual adult cash income by quarter (income rounded to nearest Bs.)

	San Antonio				Yaranda				Barttlet's Equal	Kruskal Wallis
Quarter	n	mean	median	SD	n	mean	Median	SD	variance	p
Women										
1	29	54	20	61	29	1	0	6	no	<0.001
2	32	53	27	64	30	9	3	20	no	<0.001
3	33	24	17	25	30	5	6	5	no	0.03
4	31	20	8	32	27	6	0	19	no	<0.001
5	38	49	18	89	30	3	0	10	no	<0.001
Men										
1	30	137	48	209	31	74	0	159	ok	<0.001
2	35	197	91	292	31	76	7	160	no	<0.001
3	37	84	55	104	29	112	9	221	no	0.03
4	32	119	40	173	29	115	16	289	no	0.01
5	33	148	80	209	32	92	33	206	yes	<0.001
Total										
1	59	96	40	160	60	38	0	119	no	<0.001
2	67	128	40	226	61	43	6	119	no	<0.001
3	70	56	33	83	59	58	7	163	no	<0.001
4	63	70	20	134	56	63	2	214	no	0.01
5	71	95	50	163	62	49	0	154	yes	<0.001

For both women and men combined, the highest average income from cash (128 Bs.) was in Quarter 2 which follows the period of high sales of products discussed earlier such as honey, balsa flower, and palm thatch, along with opportunities for wage work in agriculture. As cash is the principle type of income earned in San Antonio, this analysis informs us about the seasonal availability of total income for that community and explains the high fluctuations. Whether or not these fluctuations are associated with changes in health status will be addressed in later chapters.

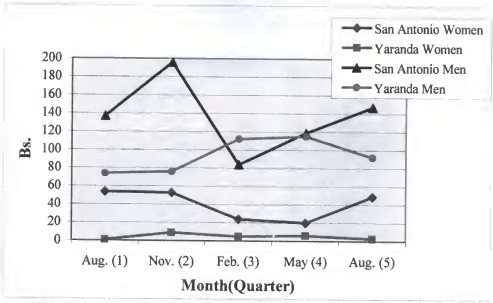

Figure 4-3. Average monthly income earned in cash by quarter and gender

In-kind income

Overall, average monthly in-kind income is lower for women than men, but also low in general compared with cash income (Table 4-7). Women in Yaranda have generally higher, but not statistically significant, average monthly in-kind income than women in San Antonio. In both communities, the median in-kind income for women is zero. Men in Yaranda have higher average monthly in-kind income in all quarters except the fourth. These differences are only significant for men in Quarter 1 ($P<0.001$).

The only substantial quarter for in-kind income in San Antonio is Quarter 4 which corresponds with the postharvest season and is likely accounting for frequent barter of rice. Reyes-García (2001) suggests that the high average in-kind income for both women and men in Yaranda during Quarter 1 is attributed to the brief presence of a project that established a community store in Yaranda for barter of *jatata* panels at a more favorable price than through traders. The high variance (SD = 214) probably indicates that not all of the community members in Yaranda were using this. It is the only quarter where there

is statistically significant (P<0.001) differences in the mean when comparing women and men between communities. There were not any interesting patterns of seasonality in in-kind income (graph not shown) other than the above mentioned.

Table 4-7. Individual adult in-kind income by quarter and gender, (income rounded to nearest Bs.)

	San Antonio				Yaranda				Bartlett's Equal	Kruskal Wallis
Quarter	n	mean	median	SD	n	mean	median	SD	variance	P
Women										
1	29	0	0	0	29	19	0	37	no	<0.001
2	32	4	0	14	30	9	0	19	ok	0.25
3	33	0	0	1	30	1	0	5	no	0.63
4	31	13	0	51	27	0	0	1	no	0.28
5	38	2	0	6	30	3	0	6	yes	0.31
Men										
1	30	0	0	0	31	92	20	294	no	<0.001
2	35	4	0	13	31	27	0	65	no	0.26
3	37	1	0	4	29	6	0	21	no	0.63
4	32	47	0	119	29	1	0	7	no	0.28
5	33	1	0	4	32	14	0	37	no	0.31
Total										
1	59	0	0	0	60	57	8.5	214	no	<0.001
2	67	4	0	14	61	18	0	49	no	<0.001
3	70	1	0	3	59	4	0	15	no	0.44
4	63	30	0	93	56	1	0	5	no	0.01
5	71	1	0	5	62	9	0	27	no	0.05

Source of Income

The source of income earned by individuals and households may factor into its disposal. The most important source of Tsimane' income is the direct exchange of goods through sale or barter (Table 4-8). On average the greatest proportion of total monthly income recorded in the economic surveys is derived from the sale or trade of goods (43%). Sale and barter are even more important sources of income for residents of San Antonio (mean = 58% of total income, median = 96%) where there is greater access to

markets and opportunity to respond to the demand for agricultural and forest products. In Yaranda, this is less pronounced but still the greatest source of income (mean = 27%, median = 0%) on average. By comparison, wage income accounts for only an average of 15% of total income for the pooled sample (San Antonio = 14%, Yaranda = 17%).

Table 4-8. Characteristics of individual monthly income, average percent of total income by source

	San Antonio			Yaranda			Total		
	mean	median	SD	mean	median	SD	mean	median	SD
Source of Income									
Wage Labor	14%	0%	0.32	17%	0%	0.36	15%	0%	0.34
Sale/Trade	58%	96%	0.47	27%	0%	0.42	43%	1%	0.47
Gift	5%	0%	0.18	22%	0%	0.39	13%	0%	0.31

Income earned through sales or barter

By community, average monthly income from sale or barter is significantly higher for adults in San Antonio in all quarters except the first ($P<0.001$) (Table 4-9). Women's economic activity is concentrated in sale or barter activities. On average, women in San Antonio are more active in sale and barter exchanges across all five quarters ($P<0.02$). The median income for women in Yaranda is zero. There is greater variance in average income for women in San Antonio, with a lowest average income reported in Quarter 3.

The average monthly income from sale or barter for men is greater in San Antonio in all quarters ($P<0.001$) except Quarter 1, when income from sales or trade is significantly higher for men in Yaranda ($P<0.02$). Highest average income from sales or trade for men in San Antonio was reported in Quarter 4 which corresponds to economic activity during April or the height of rice sales, end of the wet season, in the postharvest season.

Table 4-9. Individual adult monthly income from sales and barter by gender and community (income rounded to nearest Bs.)

	San Antonio				Yaranda				Barttlet's Equal	Kruskal Wallis
Quarter	n	mean	median	SD	n	mean	median	SD	variance	p
Women										
1	29	54	20	61	29	19	0	37	no	0.02
2	32	54	22	66	30	8	0	17	no	<0.001
3	33	24	15	25	30	2	0	6	no	<0.001
4	31	30	12	56	27	1	0	4	no	<0.001
5	38	42	17	85	30	3	0	6	no	<0.001
Men										
1	30	41	8	71	31	95	20	293	no	0.02
2	35	84	30	139	31	19	0	28	no	<0.001
3	37	44	19	55	29	20	0	83	no	<0.001
4	32	125	60	180	29	35	0	152	no	<0.001
5	33	36	0	53	32	28	4	49	no	<0.001
Total										
1	59	48	20	66	60	58	9	214	no	0.39
2	67	70	24	110	61	13	0	23	no	<0.001
3	70	34	16	44	59	11	0	59	no	<0.001
4	63	78	28	141	56	19	0	110	no	<0.001
5	71	39	10	72	62	16	0	37	no	<0.001

Income earned in wage labor

Table 4-10 summarizes the data on wage labor activities across all five quarters disaggregated by community and gender. Gender is a more significant factor to participation in wage employment. As discussed in an earlier section, women do not account for a significant portion of the wage labor reported. The higher average wage labor for women in Yaranda is attributed to a woman that worked in plant collection and surveys for the research team.

Table 4-10. Adult monthly income from wage labor activities by gender and community for each quarter (income in Bs.)

	San Antonio				Yaranda				Barttlet's Equal	Kruskal Wallis
Quarter	n	mean	median	SD	n	mean	median	SD	variance	p
Women										
1	29	0	0	0	29	1	0	6	no	0.82
2	32	0	0	0	30	6	0	22	n/a	0.65
3	33	0	0	0	30	0	0	0	n/a	
4	31	2	0	14	27	4	0	19	no	0.96
5	38	7	0	44	30	2	0	9	no	0.96
Men										
1	30	96	0	194	31	71	0	159	yes	0.82
2	35	115	0	241	31	81	0	169	no	0.65
3	37	39	0	105	29	92	0	212	no	1.00
4	32	41	0	115	29	79	0	186	no	0.96
5	33	107	0	213	32	76	0	212	yes	0.96
Total										
1	59	49	0	126	60	37	0	119	yes	0.97
2	67	60	0	182	61	44	0	126	no	0.78
3	70	20	0	78	59	45	0	155	no	0.66
4	63	22	0	84	56	43	0	139	no	0.43
5	71	54	0	156	62	40	0	156	yes	0.67

Disposal of income earned through wage labor activities

Wage labor activities are typically paid in lump-sums often split between an advance and a final payment on completion of the contract. By comparison, sales are most often transacted with immediate returns in the from of cash or in-kind payments. More continual flows of income have been shown to be directed toward food purchases (von Braun and Kennedy 1986), while large lump payments characteristic of wage earnings go toward consumer durables.

During our research, we ethnographically observed that cash earned from wage labor activities is quickly spent on market goods of prestige such as bicycles, radios,

clothing, ammunition, or prepared foods. Some wage labor opportunities take males away from their communities for extended periods of time. Upon return, they bring home cash or products purchased from their wages, but it was uncommon for remittances to be sent back to the communities while away.

Individual Wealth of Material Assets

We asked about the ownership of 22 material assets each quarter during the economic survey. Wealth assets might figure into the models of health status in different ways. Each of these items can be classified as of traditional or modern origin (Table 4-11). The label of traditional conveys that the items are manufactured by Tsimane' at the home from materials found in the local environment. I use modern to indicate items manufactured and acquired through the market economy (e.g., cooking pots), might serve to hold a stock monetary value (e.g., small farm animals), and can be easily sold or traded as needed in times of shock such as illness.

Table 4-11. List of material assets used in wealth survey

Traditional Assets	Modern Assets
Adult hunting bow	Axe
Dugout canoe	Bicycle
Wooden mortar/pestle	Chicken
Woven bag	Cow
	Dog for hunting
	Duck
	Fish hook
	Fishing net
	Flashlight
	Knife
	Machete
	Metal cooking pot
	Mosquito net
	Outboard motor
	Pig
	Radio
	Rifle
	Shotgun

The appropriation of market-based values of material wealth are evident among the more market-involved Tsimane'. Accumulation of modern assets involves engaging the market economy as both a producer and a consumer. Wealth accumulation is a complex issue. On the one hand, income directed toward the accumulation of material assets may draw away from purchases that would directly improve household welfare. At the same time, wealth assets can serve as a stock value to be converted into cash or traded during times of shocks.

Higher values for individual traditional wealth represent less acculturation, whereas, high values of modern assets are used as a proxy for some aspect of integration into the market economy and culture. For example, some men in San Antonio, especially the younger adults, do not know now how to make or skillfully use a hunting bow and arrow. Traditionally woven bags or saraij' are the principle means of transporting goods for both women and men. In San Antonio, we observed greater use of nylon backpacks purchased in town as alternatives. Community members acknowledged the longer durability of saraij' compared with backpacks, but they are also a symbol of traditional native lifestyle and stand out when used in the market town.

Modern wealth

Material wealth is a product of long-term accumulation. For that reason, I do not expect it to vary much from one quarter to another. Summaries of average individual quarterly wealth are presented in Table 4-12. Average modern wealth for males is similar for both communities. Women in San Antonio reported higher average modern wealth than women in Yaranda ($t = -7.26$; $P < 0.001$). The average value of modern wealth reported by women in San Antonio was more than double that of women in Yaranda. There are also large differences between women and men's individual modern

wealth (t = 14.8; P < 0.0011; not shown). No significant differences were detected between adults in both communities where average modern wealth is between 729-770 Bs. (U.S. $121-128).

Table 4-12. Average quarterly adult wealth by gender and community (Bs.)

	San Antonio				Yaranda				Compare means	
	Obs.	mean	median	SD	Obs.	mean	median	SD	t-stat	P
Modern										
Women	177	392	314	358	148	162	116	157	-7.26	0.00
Men	173	1156	914	1011	154	1273	915	1144	0.98	0.33
Total	350	770	380	845	302	729	262	993	-0.57	0.56
Traditional										
Women	177	151	140	145	148	164	160	123	0.84	0.40
Men	173	147	50	204	154	186	150	152	1.97	0.05
Total	350	149	100	176	302	175	160	139	2.10	0.40
Total										
Women	177	543	492	421	148	326	298	215	-5.69	0.00
Men	173	1302	1008	1111	154	1459	1151	1186	1.23	0.21
Total	350	918	562	91	302	904	441	1029	-0.19	0.85

Traditional wealth

The four traditional assets are also a measure of wealth as they are highly valued items and in theory could be sold. However, they are home produced and represent the persistence of traditional technologies. Knowledge and skill in their manufacturing is a traditional activity rather than an indicator of integration into the national society or market. Further, they all have substitutes of which possession would mark acculturation towards new customs and material assets. Average traditional adult wealth is predictably lower than modern wealth since there are fewer assets on the survey list. There is less variation in value of traditional wealth. The only significant difference is between men, where men in Yaranda have on average higher values of traditional wealth (t = 1.97; P =

0.05). These findings fit with our general ethnographic observation that men in Yaranda still manufacture and use hunting bows and canoes and handmade bags made by Tsimane' women more often.

Total wealth

The average value of total individual quarterly wealth is much greater for men than women in the sample ($t = 14.0$; $P < 0.001$; not shown). Within each community, I find greater variation in wealth among women in San Antonio (SD = 492) and among men in Yaranda (SD = 1186). It is evident that wealth, especially among men varies greatly within a community. Average total wealth is significantly higher for women in San Antonio than Yaranda ($t = -5.69$; $P < 0.001$).

Household-Level Measures of Market Integration

In the analysis of different indicators of child health status in the forthcoming chapters, I use measures of parental or household market participation and acculturation as explanatory variables. Therefore, I provide a summary of household-level measures of the key market variables.

Household-Level Income

Table 4-13 summarizes household-level measures of income for each community. Household-level income measures are a sum of income from all adults living in the household during each quarter of study. Average monthly household income across the five quarters ranges from 171-398 Bs. (U.S. $28-66) in San Antonio to 150-216 Bs. (U.S. $25-36) in Yaranda. Patterns similar to the distribution of adult monthly income from cash or in-kind are evident at the household-level. Overall, average monthly household income is higher for San Antonio in all quarters, except for Quarter 3 which, corresponds to the preharvest period. These differences are only moderately significant in Quarter 2

(P = 0.06). The median household income in Yaranda is consistently lower (as much as five times lower) than in San Antonio.

Table 4-13. Summary of household-level monthly income (Bs.) by type, gender, and community

	San Antonio				Yaranda				t-test	
Quarter	n	mean	median	SD	n	mean	median	SD	Equal Var	P
Total Income										
1	22	260	160	283	18	216	100	280	yes	0.62
2	23	398	190	411	19	194	73	276	no	0.06
3	25	171	149	128	17	181	47	277	no	0.89
4	23	254	189	222	22	162	30	332	no	0.28
5	27	264	185	267	24	150	43	234	yes	0.11
Cash Income										
1	22	260	160	283	18	125	10	285	yes	0.14
2	23	390	190	410	19	137	29	266	no	0.02
3	25	170	149	128	17	168	33	279	no	0.97
4	23	178	107	219	22	160	30	331	no	0.82
5	27	259	185	265	24	128	38	233	yes	0.07
In-Kind Income										
1	22	0	0	0	18	91	53	115	n/a	n/a
2	23	6.4	0	16	19	57	10	135	no	0.12
3	25	1	0	5	17	13	0	28	no	0.11
4	23	75	20	145	22	2	0	9	no	0.02
5	27	5	0	10	24	22	0	49	no	0.09

Household Groupings by Income Thirds

An average monthly income for each household was created using the average of all observations of income in the study (max.= 5 quarters). From the monthly income of each household, I created income groupings based on three tiers of being in the lower, middle, and upper thirds of average income. These groups are useful for descriptive analysis of bivariate relationships between household income and dependent measures of health. Table 4-14 displays the three groupings by range of income and percent of

households in each group by community. The groupings of the income thirds by household reflect significant community differences ($Chi^2 = 430.3$; $P<0.001$). The lower third of average monthly household income consists of half of the households from Yaranda. By the same token, the upper thirds are concentrated with households from San Antonio.

Table 4-14. Community distribution of households in income groupings based on average income over all quarters of measurement

Group	Average Monthly Income	San Antonio	Yaranda	Chi^2	P
Lower	<101 Bs.	13%	49%		
Middle	101 – 251 Bs.	32%	43%		
Upper	>251 Bs.	55%	8%	430.3	0.00

Household Income Measured through Daily Consumption

Consumption of farm and forest goods is an important component of household income in a rural economy. We measured consumption as the imputed value of all items entering the household during a single day. Since observations were made on random days, any one of the days should provide a valid estimate of daily consumption. I exclude purchased tools such as axes and machetes because they are durable goods not immediately consumed. Farm production includes cultivated crops, fruit trees and orchards, and animal resources. Forest goods include game, fish, and wild plants. Elsewhere (Godoy et al. 2002) forest consumption has been estimated to include persistent crops in fallow agricultural plots, however, because they are anthropogenic and not part of the composition of primary-growth forest, I include fruit orchards under farm consumption. Market produced items also enter households but since they are acquired through cash or trade, they are already accounted for during estimates of monthly income. I include market items consumed by households such as sugar, salt, and

batteries for comparative purposes. Our team calculated a monetary value of each good entering the household by using the labor value expended to procure the item or the selling price of the item.

Table 4-15. Quarterly average composition of daily household consumption by source and community (Bs./household)

		San Antonio		Yaranda		Both Communities	
Quarter	Source	Bs.	%	Bs.	%	Bs.	%
1	Farm	9.70	45	9.07	44	9.41	45
	Forest	19.18	50	20.75	49	19.90	49
	Market	0.87	5	0.19	6	.55	6
	Total	29.74	100	30.01	100	29.87	100
2	Farm	20.68	62	8.56	40	15.30	52
	Forest	10.89	30	13.84	58	12.20	43
	Market	2.99	8	0.08	<0	1.69	4
	Total	34.56	100	23.10	100	29.47	100
3	Farm	13.63	48	7.76	41	11.09	45
	Forest	11.19	38	7.19	48	9.46	43
	Market	5.10	13	1.44	10	3.50	12
	Total	29.91	100	16.39	100	24.07	100
4	Farm	11.88	47	9.44	58	10.74	52
	Forest	30.15	39	11.64	42	21.51	41
	Market	4.18	14	0	0	2.23	7
	Total	46.21	100	21.07	100	34.48	100
5	Farm	6.47	30	10.76	55	8.57	43
	Forest	27.71	54	6.92	41	17.54	47
	Market	6.61	16	1.55	4	4.14	10
	Total	40.79	100	19.23	100	30.24	100
Total	Farm	12.57	47	9.18	48	11.01	47
	Forest	19.68	42	11.96	48	16.13	45
	Market	3.98	11	0.66	4	2.45	8
	Total	36.23	100	21.93	100	29.65	100

Table 4-15 reports daily household consumption for each quarter disaggregated by source of goods. On average, forest goods account for a higher average value of daily consumption (16.13 Bs.) than farm goods (11.01 Bs.) or market goods (2.45). There was

a higher number and diversity of forest plants used in Yaranda. Firewood was the most important forest resource entering the household (Godoy et al. 2002).

Table 4-16 presents results from the comparison of mean values of daily household consumption by each of three sources, total value, and per capita within household. We estimated household size by counting the number of people present at a mid-day meal. If no meal was eaten, we relied on the composition of the household the night immediately prior to the days of observation. The results indicate that consumption from all sources is significantly higher in San Antonio. Table 4-16 shows that community differences in value of household consumption are significant for only farm and market goods ($P<0.04$) and modestly significant for forest goods ($P<0.06$). Reyes-García (2001) questioned the validity of the individual estimates of prices of items, especially in the more remote community where it was unlikely that some goods have a selling price and they may be undervalued.

Table 4-16. Comparison of average measures of consumption by source

	San Antonio	Yaranda	Both	Between Community	
Source	Bs.	Bs.	Bs.	t-stat	P
Farm	12.57	9.18	11.01	2.10	0.04
Forest	19.68	11.96	16.13	1.92	0.06
Market	3.98	0.66	2.45	3.26	0.00
Total	36.23	21.93	29.65	3.26	0.00
Per capita	7.90	4.48	6.33	2.81	0.01

Still, the data are useful for comparing the proportion of daily consumption from farm, forest, or market sources (Table 4-17). Overall, farm (47%) and forest (45%) goods contribute the most measured as percentage of total value of household consumption. Market goods only account for an average of 8% of total value of household consumption. These results tell a different story than the comparison by

monetary value. By proportion of total consumption, community differences are only evident between proportion of daily household consumption coming from market goods ($t = 2.70$; $P = 0.01$). In Yaranda, on average a greater proportion of household daily consumption comes from forest origins (48%) compared to San Antonio (42%), but these differences are not statistically significant. One would expect the dependence on forest resources to be lower in communities closer to towns (Godoy et al. 2002).

Table 4-17. Comparison of source of total consumption by community

	San Antonio	Yaranda	Both	Between Community	
Source	%	%	%	t-stat	P
Farm	47	48	47	-0.27	0.78
Forest	42	48	45	-1.20	0.23
Market	11	4	8	2.70	0.01

Household-Level Wealth

Even though our measure of individual-level wealth attempted to capture ownership, there is some uncertainty as to whether reported ownership approximates actual usufruct rights to assets. The health effect of wealth assets in a household may extend beyond the owner to other household members who have access to the assets. The data for household wealth contains one distant outlier in the household of the main professor in Yaranda because he owns an outboard motor, the most valuable modern wealth item on our list. I ran average household wealth for the community, both with and without that household. Similar to individual-level wealth, I do not expect household wealth to vary much from quarter to quarter and therefore do not report quarterly summaries. The results appear in Table. 4-18.

At the household-level, there are no differences in average value of total wealth between the two communities, whether the outlier household is included in the analysis

or not. Significant community differences exist between household modern wealth when the outlier is excluded (P = 0.05), with higher average and median modern wealth found in San Antonio. Households in Yaranda report higher values (P = 0.01) of traditional wealth items.

Table 4-18. Average quarterly household wealth

	San Antonio				Yaranda					
	Obs.	mean	median	SD	Obs.	mean	median	SD	Equal Var	P
Total Wealth										
Outlier	128	3245	3106	1864	107	3927	3116	4796	no	0.16
Without outlier					102	2925	2977	1544	yes	0.16
Modern Wealth										
Outlier	128	2832	2724	1722	107	3405	2571	4724	no	0.23
Without outlier					102	2412	2410	1442	yes	0.05
Traditional Wealth										
Outlier	128	414	415	288	107	522	461	323	no	0.01
Without outlier					102	513	456	324	no	0.01

Factor of Market Integration and Acculturation

Thus far, I have discussed summary analyses of measures of acculturation and integration into the market economy that will serve as independent variables in the analysis of their impact on health. One potential obstacle to identifying relationships between independent variables and dependent measures of health is multicollinearity or a high degree of correlation between independent variables. Multicollinearity can mask any partial effects of independent variables on health. The different proxy measures for acculturation and market integration may act jointly to affect individual health status, rather than any single variable determining outcomes.

Factor analysis is one multivariate statistical method for managing problems of multicollinearity. Principal components factoring examines data values for any

underlying dimensions or patterns of interrelationships among correlated variables (Agresti and Finlay 1997; Bernard 1995). The mathematical procedure takes into account the interdependence of each variable in a generated matrix of intercorrelations, for example, all of the observations for the different measurements of market integration. If a matrix is dense, then only a few factors are necessary to explain a lot of the variance in the matrix (Handwerker and Borgatti 1998). The factors that are produced are a composite of the original variables. Factor loadings refer to how highly correlated a variable is with its new factor (cf. Agresti and Finlay 1997; Handwerker and Borgatti 1998 for a detailed discussion of factor analysis). By examining factor loadings it is possible to identify the concepts being captured in each new factor.

To test whether the different variables measuring market integration and acculturation can be combined into one or more new principal factors, I conducted principal components factor analysis. First, I factored six variables of acculturation measured in the baseline demographic survey on adults: highest school grade, years of schooling, math skills, literacy in Spanish, literacy in Tsimane', and Spanish oral competency. A single factor emerged explaining 71% of the variance in the matrix with all factors loading high (loadings > 0.60). This is strong evidence that only one underlying factor is represented by the six individual variables, a factor I labeled as "educational skills." This single factor accounts for the packaged effect of different aspects of acculturation through achievement of formal education and skills. The single factor can be substituted for individual variables in the regression analysis.

Second, I ran principal components factor analysis on the four variables for types of income and wealth. The results produced two factors which together account for 64%

of the variance in the matrix. Cash income and modern wealth load high on the first factor labeled "cash/wealth factor." Income earned in-kind and credit load high on a second factor labeled "kind/credit factor."

Third, I factored the raw measures (not log transformed values) of quarterly wealth, income, and credit. A single factor accounts for 50% of the variance in the matrix with income and wealth loading high (loadings >0.70) and credit moderately (loading >0.50). These loadings suggest that income and wealth cluster together with high correlations between the new factor labeled "MI factor."

Table 4-19. Characteristics of adult factors of market integration and acculturation

Factor	Mean	SD	Median	Min.	Max.
MI Factor	0.08	1.06	0.08	-0.85	6.80
Acculturation Factor	-0.07	0.96	-0.07	-0.94	2.80
Cash Wealth Factor	0.10	1.07	-0.28	-0.98	6.86
In-Kind Credit Factor	-0.01	0.74	-0.23	-1.58	7.27
Household Income Wealth Factor	0.08	1.03	-0.20	-1.06	5.13
Household Cash Wealth Factor	0.13	1.05	-0.11	-1.21	5.64
Household In-kind Credit Factor	-0.02	-0.86	-0.32	-0.96	4.81

Finally, I repeated the factor analysis of market integration using household-level measures. A single household-wealth factor emerges. However, if I factor income by type of income (cash or in-kind) two different factors results: one representing household cash income and wealth and another with household credit and in-kind income grouped together (Table 4-19).

Chapter Conclusion

The Tsimane have been described as the "least integrated and acculturated swidden cultivators in the rain forest of Bolivia" (Huanca 1999:7). If this is a valid portrayal, then they represent an ideal case for examining the relationships between integration into the

market, acculturation and other outcomes. Within this chapter I have described Tsimane' acculturation and integration into the market society, comparing community, household, and individual-level measures. What stands out is the variation in measures of acculturation and integration both within and between communities. This variation is going to be important to explore in my investigation of how it might influence health outcomes. The high degree of variation within communities on the different measures calls attention to the need to look within the household in addition to the individual, while still controlling for community attributes. Distance from the market town, the major distinguishing feature between the two study communities, alone cannot explain differences in market integration. Our data affords me the opportunity to compare individuals living in the same community, but with wide variation in income, wealth, and human capital to see if these factors are influencing the different indicators of health that I analyze within this dissertation.

Analyzing economic activities over several time periods in the annual cycle better completes the picture of Tsimane' resource use and availability. Seasonality is an important factor to consider when analyzing health outcomes in the tropics. Seasonal patterns in mode and degree of market integration are evident for each in the study communities. The analysis of measures of Tsimane' economic participation in the market system reveals sharp seasonality to availability of cash income and type of economic activity. There is a general pattern of smoother average monthly income for both adults and aggregate households in the more remote community of Yaranda, than in the more market integrated community of San Antonio. On average, adults in San Antonio are more tied into the market economy, with high levels of participation in wage

labor, sale and barter, especially among the men. The more variable income flows in San Antonio follow more of lump sum payment pattern and could be directed toward acquisition of consumer durables. More constant, albeit smaller sums of income, through the very structure of trade directly for smaller items in Yaranda may be more beneficial to the overall health of the household.

Gender differences in measures of acculturation and market integration are another finding from my analysis of the explanatory variables. Regardless of community of residence, adult males consistently demonstrate higher levels of acculturation and integration into the market economy than adult females. The exposure, participation, and influence of acculturative forces do not appear to have equally affected women and men. The gender difference in measures of acculturation and economic integration among Tsimane' adults have not been previously addressed to a large extent. Reyes-García (2001) noted differences in ethnobotanical knowledge, but did not discuss the differences in measures of integration between women and men. The literature on both adult and child health in the developing world has emphasized the need to look at gender differences in economic and social factors that affect health such as education, income, and dietary intake. My analysis of the explanatory variables reiterates the need to disaggregate these measures by sex.

Comparing the general patterns of acculturation and articulation with the market economy between San Antonio and Yaranda contributes to my understanding of the relation between integration and health. In the following chapters, I turn the focus toward how these differences in market integration and acculturation might influence different

measures of health status. I explore the relationships between frequency of illness, dietary intake, and nutritional status.

CHAPTER 5
GENERAL HEALTH CONDITIONS IN THE STUDY COMMUNITIES

Health Related Factors of Tsimane' Way of Life

The historical background, social organization, and modes of subsistence are all important pieces in setting the stage for an analysis of how economic forces might affect human health. While Tsimane' subsistence practices have been studied in detail (Apaza Vargas 2002; Chicchón 1992; Huanca 1999; Pérez 2001; Piland 1991; Reyes-García 2001), no researcher has concentrated on Tsimane' health status and behaviors. The following section contributes to our knowledge of the Tsimane' by describing community attributes such as infrastructure, health related behaviors, available health services, reproductive health, and recreational habits important to understanding the broader picture of Tsimane' health and welfare.

Infrastructure

Power and Water

Neither of the two study communities had a source of potable water or electricity when our team arrived in May 1999. For illumination, the Tsimane' use small kerosene lamps or store-bought candles and for the most part, activity in the communities winds down at nightfall. At the time of writing, there is still no source of electricity in either community.

In Yaranda, residents collect drinking water from either the Maniqui River or the Arroyo Majsi', a nearby stream offering a clearer water supply. A little over halfway through our research a bucket-well was built in Yaranda as a byproduct of a municipal

government project to construct a new concrete school building. The well was built to facilitate mixing of cement close to the school grounds by masons. The well is a great source of pride for the community and serves the households located closer to the school than the river.

In San Antonio, households collect water directly from the bank of the Maniqui River year-round. Because of its location downriver from San Borja, residents claim the water is contaminated due to waste dumping from town. However, chemical analysis of the river water to confirm or refute these claims has not been undertaken. During the rainy season when the river crests, the water becomes dark and full of matter. Some households try to catch rainwater, but for the most part, they make efforts to let the matter in the river water settle down in containers before using it. In both communities, the chore of collecting water for household use falls on women and children. In general, women spend more time in the river than men washing clothes, collecting water, and bathing young children.

Two water projects aimed at digging fresh water wells in San Antonio started during our research but were abandoned by the NGOs and engineers involved. The mistrust and deception felt by the residents led to a drop in credibility of that or any future projects. When we ended the 18-month period of fieldwork residents were still without any hope of meeting the need for a cleaner water source in this community. Upon return to San Antonio in August 2002, I was both pleased and surprised to learn that household-level manual groundwater pumps and spigots were completed and in full use (one per every two households). It was remarkable to see that this community finally achieved their goal and the vital necessity of a cleaner water supply. The possible health

effects of this cleaner source remain undocumented as it did not exist during the study period, but residents expressed great satisfaction about the pumps.

Housing and Climate

Traditionally, Tsimane' housing structures are not enclosed on all sides. Often a single wall on the windward side is erected while the other three sides remain exposed. More and more it seems that Tsimane' are beginning to enclose their houses with shuru' *(Gynerium sagittatum),* a bamboo-like plant used as fencing material, and even add doors with locks. This is especially apparent in San Antonio. Residents explained it as a measure to safeguard valuables, as well as protect the inhabitants from the weather. There were not significant differences in building materials or quality of the homes, apart from walls, that merited measuring residential structures as is often seen in health studies in rural areas.

We measured and recorded daily minimum and maximum temperatures, as well as daily rainfall in each of the communities. From June to August when the southern cold fronts move through the Beni, temperatures can drop to a low of 6°C (43°F) and high of 16°C (61°F). Strong, cold winds whip through the communities blowing dust and cold air through the walls of the houses to reach residents inside. Many Tsimane' families still sleep on woven palm mats laid directly on the cold dirt floors of their houses. Others have opted to build simple shelf beds a foot off the ground to keep themselves warmer. When the cold fronts come through, family members pile all the available clothing on top of themselves for warmth at night. Some may move a fire inside their shelter, but most weather the cold fronts in bed. During our study, the highest temperatures were recorded in October and November with highs of 42°C (104°F).

Figure 5-1 displays measures of monthly rainfall for the two communities during the research period. Annual rainfall was 30% higher in Yaranda (2113 mm) than in San Antonio (1459 mm). These estimates are based on data spanning September 1999 to August 2000, the period during which there was greatest coverage of rainfall measures.

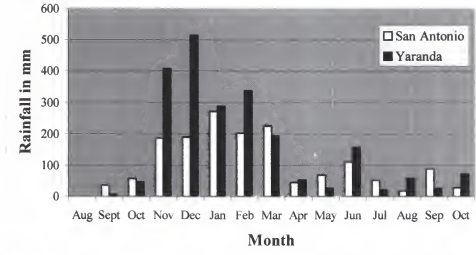

Figure 5-1. Monthly rainfall August 1999-October 2000

Personal Hygiene, Behaviors, and Habits

The Tsimane' maintain a regular routine of bathing in the river or stream. Soap is used depending on availability. Each individual either washes their clothing at the time of bathing, or women or older female children will wash for the entire household several times a week. Washing clothes becomes more difficult during the rainy season as the river crests and fills with debris. During this time, clothing does not dry and often mildews in the steady humidity.

Most Tsimane' spend all day barefoot, whether they are walking in the forest or through the community, and are thus prone to foot fungus and skin problems related to exposure to moisture. The Tsimane', especially women and children, frequently inspect

one another's scalp for lice and nits. Lice are endemic in Tsimane' communities and are considered to be more common in women because of their longer hair.

Oral hygiene usually consists of rinsing one's mouth after a meal. Some individuals who have picked up the urban habit of teeth-brushing can be seen in possession of a toothbrush and paste from time to time. Visible decay, tooth loss, and exposed gums are obvious in almost all individuals, both young and old. A diet high in carbohydrates likely contributes to the rampant decay. Tooth pain was a frequently reported ailment among adults, a cause of great discomfort, and costly to treat if extraction becomes necessary. In San Antonio, some adults have had dentures put in. One man in the community sold his hunting rifle in order to pay for the procedure.

Waste Disposal

The Tsimane' traditionally do not have latrines at their households. The most common method for human waste disposal is done in private in the forest, away from the residential unit. Because of the low population density, this practice lowers the possibility of direct contamination of waste with the human habitat. However, very young children often defecate in the patio areas of the houses, whereby women or older children will quickly shovel it away and clear the dirt floor. Even so, animals such as dogs and chickens are often seen defecating indiscriminately near the houses. In a few Tsimane' communities, such as La Cruz, the New Tribes missionaries involved the residents in latrine projects in which each household dug their own. Digging a latrine is not so labor intensive compared to other activities; still, latrines are not universally used by the Tsimane' because it is not their custom or habit.

The school complex in San Antonio has two cement latrines intended for the students. During our fieldwork, I observed that the latrines are not regularly used nor

kept in a hygienic state. There is no toilet paper available in these latrines, whereas in the forest there are readily available substitutes. The teacher and technical assistant remarked that it is difficult to instill this habit, as it is not custom to the students. Many students still consider the forest as more convenient and a cleaner option. The new school built during our study in Yaranda is equipped with two small latrines built in a tight space that do not offer full privacy. Other members of the research team observed that the school latrines were used even less in Yaranda than in San Antonio.

Studies of prehistoric populations in transition inform us that incidence of parasitic diseases should increase with increased sedentism because of the probability of higher contact with human waste (Armelagos 1990). A settled population risks contamination of their water supply from inappropriate human waste disposal, something that low population density and migratory practices preclude. With acculturation and less shifting of communities there is greater probability of coming into contact with fecal matter (Lawrence et al. 1980). In a community like San Antonio, increased population pressures from immigration increases the amount of human and animal waste surrounding the community and could potentially increase the risk of disease transmission.

The Tsimane' dispose of organic materials at or near the borders of their residential patios. They have the custom of sweeping their dirt patios and pushing organic trash off to the edges. Inorganic items such as tin cans and plastic bottles are either re-used in the form of implements, containers, or even toys, or else they are burned or discarded in holes dug for that purpose. Because of these practices, organic and inorganic trash does not constitute a health risk because of their appropriate disposal.

Use of Alcohol, Tobacco, and Coca Leaves

During the quarterly illness surveys, we asked all adults about their patterns of use of certain recreational substances. Table 5-1 presents the results and comparison by community using two sample t-tests with an unequal variance option.

Table 5-1. Average adult recreational consumption habits in the last week by gender and community for all 5 quarters (n= 598)

	San Antonio				Yaranda				
	Women		Men		Women		Men		Between
Habit	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Community p
Number of days									
Coca Leaf	0.7	1.8	2.0	2.7	0	0.1	0.1	0.5	<0.001
Alcohol	0.2	0.4	0.9	1.2	0	0.1	0.2	0.6	<0.001
Chicha	0.8	0.9	1.0	1.0	0.7	0.8	0.9	0.9	0.53
Number of cigarettes									
Smoking	0.2	0.8	3.9	9.0	0.1	0.9	0.9	3.1	<0.001

Alcohol consumption

The use and abuse of alcohol is an emerging problem for the Tsimane', predominately among adult males and represents a diverting of economic resources away from the household. This historical tool of domination and exploitation of Tsimane' labor has become a crutch on which many males lean. Alcohol (96% concentration ethanol) has traditionally been used to manipulate males into labor contracts and can be a mechanism through which they are taken advantage of in exchange relations both with traders and in direct sales.[14] During my residence in San Antonio, I observed the abuse of alcohol among men markedly increase. In part, this was tied to non-Tsimane' in-laws with histories of alcoholism settling into the community. Their arrival marked an increase in Tsimane' participation in alcohol consumption. The annual community festival has become an extended drunken party, not from the customary brewed shocdye'

[14]Our official policy among the research team was not to trade cigarettes, alcohol, or coca leaves.

(*chicha)* but from an increase in alcohol consumption. The situation escalated to the point where an evangelical Tsimane' family who does not drink or dance, saw the market opportunity and began to buy alcohol in bulk then sell it for cash or barter it for rice to the willing consumers, both Tsimane' and non-Tsimane'. Farther away from the market town, in Yaranda, this type of drinking behavior is less common and problematic. *Chicha* consumption serves a somewhat different role than alcohol in Tsimane' society and is still more common.

Table 5-1 shows statistically significant differences between reported mean alcohol consumption in San Antonio compared to Yaranda. The highest level of consumption was among men in San Antonio with an average of almost one day a week drinking some alcohol. Possible deleterious long-term physical as well as social effects include the increasing diversion of cash income to purchase alcohol and cigarettes that carry no nutritional value back to the household. Some women complained that their husbands spend their wage earnings on alcohol rather than on the needs of the family. In San Borja, the sight of Tsimane' males intoxicated and passed out on the sidewalks fuels the negative impression held by town residents that the Tsimane' are drunks and negligent towards their families.

Tobacco use

Men smoke cigarettes while hunting to keep insects at bay and during social occasions. Some Tsimane' grow and roll their own tobacco leaf, while others more frequently purchase cigarettes from town. The reported frequency of smoking was significantly higher for all adults in San Antonio than in Yaranda ($P<0.001$). This difference was due to differences in smoking frequency by the males. Women in both

communities smoke much less, and the median number of cigarettes consumed by women was zero.

Coca leaf

Chewing coca leaves is a more common behavior in San Antonio. This is probably explained by greater access to the leaves in the markets of San Borja, as well as the custom of chewing while working in agricultural wage labor to suppress appetite. The international political pressures to eradicate the cultivation of coca leaf in Bolivia and other Andean countries has made the transport and commercialization of the leaf costly and difficult. The presence of U.S. Drug Enforcement Agency (DEA) trained military units at checkpoints along the major highways in Bolivia is one factor driving up the price per pound of the product. We found that some Tsimane' grow a similar variety of coca leaf and dry it for their own consumption. In town, Tsimane' adults purchase sodium bicarbonate (*bico*) to add to coca before chewing. This compound releases the alkaloids from the leaf which help to suppress the appetite. In Tsimane' communities, ash is used as a substitute if *bico* is not available. The average number of days chewing coca leaf was higher in San Antonio (t-stat = -9.5; $P<0.001$) than in Yaranda.

Health Services

In the next section, I describe the different types of health-care services available to the two study communities. There are several possible options for medical treatment including home remedies, traditional healers, pharmaceuticals, private physicians, and hospitals. Some preventive biomedical measures are available, such as free vaccinations.

Traditional Options

Traditional healers

There were no recognized shaman or traditional healers in San Antonio and Yaranda. San Antonio's two neighboring Tsimane' communities, Campo Bello and Puerto Mendez, are home to traditional Tsimane' healers and residents of San Antonio reported consulting them during illness. Standard treatments reportedly used by the healers included sucking out thorns from the skin, rubbing alcohol on the body, and smoking tobacco. A healer lives in the community of Cosincho, upriver from Yaranda, where many residents have relatives and visit regularly. The healer knows how to heal with corpa, a technique involving reading a gourd of urine from a child and interpreting the image. This technique has been sought for extreme cases of illness, as nobody in Yaranda knows how to perform this cure. Payments to traditional healers in cash ranged from 5 Bs. to 30 Bs. with the option for credit. Payment in-kind was often completed through chickens or rice. Compared to the cost of treatment in San Borja, this is generally a more economically feasible option. An investigation of the techniques used by traditional healers for diagnosis or treatment is beyond the scope of the present study.

Home remedies

Within the household, traditional plant remedies are used to treat illnesses. Different parts of a plant are used for different cures (cf. Mayer Roca and Clemente Caymani 1999 for chart of traditional medicines by illness). A wide range of medicinal plants were collected and mapped out as part of a study on ethnobotanical knowledge (cf. Nate, Ista, and Reyes 2001 for detailed catalog of medicinal plants found in Yaranda). The depth of knowledge of ethnobotanical medicine varied. We found some families to draw on more extensive knowledge of home remedies than other families.

Some of the more common home remedies captured in our seven-day recalls were cos (tobacco- *Nicotina tabacum*), oveto' (*uña de gato- Uncaria guianensis*), eré (*ajillo- Petiveria alliacea L.)* and sauté (ginger root- *Zingiber sp.*) in Yaranda and ashasha (lemon- *Citrus limon L.*), conojfoto (*ochoó- Hura crepoitans L.*) shepi' (*ajo ajo – Gallesia integrifolia*), cos (tobacco) and Cotí (*guayabo-Psidium guajava L.)* in San Antonio. One traditional practice used by the Tsimane' in both communities is the painting of newborn children with juice from tyi' (*bi-Genipa americana L.*) fruit which produces a dark purple to ashen-black layer of dye on the skin. This practice is a preventive measure against skin acne and fungus caused by the heat and humidity, to darken their skin, and to avert other illnesses such as fever.

Biomedical Options

Research team first-aid kits

At the start of our field work in May 1999, our research team had to decide how much we would intervene when diseases were presented to us during the course of our study (Jelliffe and Jelliffe 1989), especially because of the health component. In each community, we ran a basic medical kit with first-aid supplies such as oral re-hydration preparations, pain-killers, snake-bite anti-venom, and medicinal ointments. For more severe health conditions, our policy was to offer loans up to 50 Bs. that borrowers could work off or repay in-kind with food and supplies we needed. Only a few people who took loans opted to repay us in cash. We did not make loans for other activities, with the exception of salary advances to our regular translators. We kept record of the illnesses and medications that we disbursed from our basic first aid kit in both communities. The most common complaints and requests for medication from our first-aid kit were headaches, diarrhea, conjunctivitis, and fevers. There were several health emergencies

during our study including a fatally dehydrated infant, appendicitis in a Tsimane' visitor to Yaranda, and a machete wound to the head of an adolescent for which we assisted with transport and gaining access to treatment in San Borja.

Permanent biomedical options

Other sources of biomedical remedies include river traders, missionaries, and the pharmacies and hospital in San Borja. Biomedical medications are sold over-the-counter in Bolivia. Throughout the study I learned that when many Tsimane' adults would report that they had "gotten advice from a doctor" on what to buy, they had been advised by a pharmacy owner, who was often a business owner rather than a trained health provider. The Tsimane' use several inexpensive remedies for multiple purposes. The most common modern remedies employed at home were vapor rubs, aspirin, and unidentified tablets of origin in a pharmacy.

Because of the relative proximity to the market town, pharmaceuticals are more readily accessed by residents of San Antonio. The need to convert wealth into cash through the sale of domestic animals or agricultural products is met relatively easily by walking to town. Some Tsimane' adults who maintain patron-client relationships with Borjanos might turn to them for financial aid in times of illness. However, this favor is irregular and unreliable.

Residents of Yaranda have access to pain killers, salves, and other basic remedies from the *jatata* traders who frequent the communities. In cases of emergency, serious injury, or prolonged illness, residents will travel downriver to Horeb, but not directly to the hospital in San Borja. Often this trip is organized through the school teacher on his motorized canoe or through the family's own means. There is a reluctance to make the arduous and costly trip and the research team in Yaranda often persuaded the grave cases

of their need to go. During our study, there were several notable illnesses such as a case of leishmaniasis on the leg of a young boy and tuberculosis that required more intense treatments from facilities in town. Because trips to San Borja by residents of the more remote community are infrequent, people stock up on common treatments such as vapor rub and salves.

Hospital or private doctors

Hospital Lourdes is a public hospital that serves San Borja and the surrounding rural populations. There are also several private medical practices in the town. A private doctor's visit can cost around 50 Bs., while a visit to the hospital is 10-15 Bs. for the consultation plus the price of the medicine prescribed (independently purchased in pharmacies by the patient or her family). Prescriptions can quickly total over 100 Bs., a considerable sum considering the average monthly incomes reported for adults ranges between 56 Bs. and 132 Bs. Should a patient need to be admitted overnight, the family is responsible for providing food and supplemental medication. This poses an obstacle to family members who do not have anywhere to spend the night while in town caring for an infirm relative. We have no record of treatment from the hospital for residents of Yaranda during the illness surveys, while 18 cases of treatment in the hospital were reported by residents of San Antonio. The experience in the hospital frequently involves being berated by the health care workers for poor hygiene or failing to seek treatment until the condition was too advanced.

Clinic at Horeb

In the past, the Gran Consejo Tsimane' and the New Tribes Mission supported a medical clinic at Horeb. Funding for this clinic, which exclusively serves the Tsimane' people, has declined. While I do not have financial record of the services or prices, there

is a general consensus that it is less well funded than it used to be. On frequent visits during our pilot phase, research team members repeatedly found the clinic closed.

Residents of Yaranda are more likely to go to the clinic at Horeb in the case of a severe illness, and never directly to hospital in San Borja. In Horeb, the nurse can make arrangements for helping them get to the hospital. By contrast, in San Antonio, residents prefer to make the day trip to the hospitals and not stay over night in Horeb. During their annual pilgrimage up the Maniqui River during the rainy season, the New Tribes missionaries sell medications at subsidized prices.

Vaccinations

There are two channels through which the Tsimane' of San Antonio and Yaranda can access vaccinations: 1) mobile vaccination brigades or 2) directly at the hospital in San Borja. Both options are free of charge. During our fieldwork, we were able to witness the vaccination brigades in both communities. Vaccination brigades from the public hospital arrived in San Antonio in December 1999 and May 2000. Both times residents were not aware of their arrival in advance. A team arrived in Yaranda in January and April 2000. The vaccination teams appeared to be hurried and have limited time in the communities. One or two nurses, accompanied by an assistant, delivered vaccines for tetanus, MMR (measles, mumps, rubella), tuberculosis, diphtheria, and polio to children. Pregnant women beyond their first trimester were occasionally provided with a month's supply of ferrous sulfate tablets to take on their own. All children between the ages of one and five were given a single vitamin A tablet. Anti-parasitic drugs, such as mebendazole, was sometimes given to all children over two years of age or to special cases, depending on available supply. In general, the vaccination teams do not travel with anyone who can translate into the Tsimane' language. Typically, a bilingual

community member is called on to help out. On occasion, children are weighed and recorded, but this is not a regimented practice. If there are severe cases of diarrhea, co-trimoxazole is distributed sometimes. According to their protocol, some of the anti-parasitic drugs dispensed should not exceed certain intervals of treatment. The absence of any written record, leaves these windows open for misuse or misallocation.

We found no formal records of vaccinations among the Tsimane'. When we asked parents about the vaccination of their children, they were unsure and generally could not distinguish between the different types or functions of the vaccinations. During vaccinations, nurses ask individuals how many vaccines they have received in their lifetime. While living in the communities, our research team encouraged the parents of newborns in San Antonio to maintain the infant vaccination schedule detailed in the pamphlet for the Seguro Básico de Salud, and offered to accompany families to the hospital. Some were interested, but others did not see the importance of the effort. This reluctance appears to be tied to an overall mistrust of the biomedical system represented by the hospital in San Borja.

When residents presented additional ailments to the nurses during the vaccination brigades in the communities, the nurses expressed their uncertainty about whether to believe the complaints or not. On one occasion, my translator became offended and defended the community, by saying in Spanish "*ellos no mienten en eso, están realmente enfermos*" ["They don't lie about this, they are really sick"]. Still, compared to the care provided in the hospital in town, the team of vaccinators are more accommodating and do not act condescending toward the Tsimane'. They could improve on the communication of instructions on how to take the medications they dispense and the schedule of

vaccinations. Compliance with biomedical prescription is a challenge to delivery of quality healthcare. Our team observed hoarding behaviors with medicines we distributed from our community first-aid kits, as well as those from vaccination campaigns and individual purchases from pharmacies. There was also the tendency to seek out multiple sources of advice and switch treatments rather than follow through with full compliance.

Vaccination campaigns prioritize the urban area before the indigenous villages. During a regional outbreak of measles in October 1999, the vaccines were slow to arrive in the ethnic communities as distribution of a limited supply focused on the population of San Borja. Some of the residents of San Antonio took it upon themselves to take their families to town for the free vaccines. However that was more of the exception than the rule. Distance obviously made this a greater challenge for residents of Yaranda than San Antonio. At one point during the epidemic, the supply of measles vaccines ran out and there was a delay in replenishing the supply from Trinidad or La Paz. Unfortunately, measles struck both Yaranda and San Antonio before the vaccine campaigns arrived, with more numerous and severe cases in Yaranda. A few cases required hospitalization, but there were no fatalities. The response to new cases of measles in Yaranda was a disruption in the community as many families moved away to live temporarily in their smaller homes in their fields or on the beach to flee the illness.

Access and Utilization of Services

The existence of these different options does not imply universal access to them. Each type of medical service carries a different price both in monetary and labor measures. For the most part, biomedical treatment options originate or are located in the town of San Borja. River traders bring limited pharmaceutical items to the upper Maniqui River for barter at inflated exchange rates. Distance inhibits access mainly to

biomedical options and has been found to be negatively associated with use of biomedical services elsewhere (Young and Garro 1982). But access alone is not the only predictor of treatment utilization. Beliefs about each of the possible treatments may also influence usage. This is particularly relevant in the decision to use medical consultation services at the hospital in San Borja or through another private doctor in town. Tsimane' express doubt over availability of free medications at the Horeb clinic, as well as misgivings that the hospital is a place a person goes to die.

Reproductive Health

Little has been written about the reproductive health of Tsimane' women. Chicchón (1992) discusses prescriptions and taboos related to spousal behavior during and after a pregnancy that affect the welfare of the unborn or newborn child. In order to understand lifetime fertility and get a general idea of reproductive health, I conducted reproductive histories with all women in the sample who were in a conjugal relationship.

Delivery and Disposition of Pregnancies

From the 64 women meeting the above criteria (total sample was 73 women), I recorded a total of 363 pregnancies, 328 (90%) which resulted in live births and or a stillborn child (one case). It was apparent that Tsimane' women are not accessing any form of prenatal health care during pregnancy. Out of a total of 363 lifetime pregnancies reported between the two communities, in only 11 cases (3%) did the woman report receiving prenatal check-up or care. This most often meant she had been given iron tablets from the vaccination brigades during the pregnancy. All of the women reporting any prenatal care were residents of San Antonio.

Most often a relative, usually female, attends the birth. Just over half the recorded births were attended by the mother or mother-in-law of the pregnant woman. There is an

interesting pattern in San Antonio wherein husbands attended the births almost 20% of the time, whereas, this was not the norm in Yaranda. In San Antonio, an older couple was known to be skilled in birthing and their assistance was called on frequently. In Yaranda, there were two specific women who filled the role of birth attendant more often than others. Because of the distance and cultural barriers already discussed, Tsimane' women are at risk should complications occur during birth. In one case, while our research team was away on vacation, a first-time mother in San Antonio had complications and was taken to the hospital in San Borja where the doctors performed an episiotomy on her to assist in the delivery. The mother is a daughter of an interethnic marriage with a non-Tsimane' mother. She and her husband are more acculturated and have a broader social network in San Borja, making their access to medical assistance more possible. In Yaranda, there was one postpartum infection that our research team treated with antibiotics.

Chicchón (1992) described taboos surrounding behavior during pregnancy and the postpartum period. After the birth, the Tsimane' bury the placenta near a tree in the yard of the residence. She reported that new mothers and newborns remain enclosed in the house for several days to weeks. In our interviews and observations, we did not find any strict time limit for postpartum seclusion. Women reported breastfeeding their children up to three years or their next pregnancy. During any quarter, we found that 40-52% of adult women were breastfeeding, representing elevated energetic costs to mothers. I found that the majority of infants less than one year of age did not yet have official names assigned to them. Some subjects informed us that names were often chosen when someone important visited the village, but the delay in naming children until they are

older could be related to high infant mortality and a reluctance to officially recognize the child until her or his survival is more likely (Scheper-Hughes 1987).

Abortion and Miscarriage

The reproductive histories revealed six (2% of total pregnancies) induced abortions; five from ingesting plant mixtures and one from hitting the stomach until the woman aborted. Women reported several different plants that could be or were consumed to induce abortion, including plants used in the *barbasco* fish poisoning technique. On one occasion, a woman in San Antonio approached me, requesting medication to help her terminate her pregnancy. The histories also revealed 23 (6% of total pregnancies) spontaneous abortions or miscarriages. Over half of the miscarriages were attributed to falls/accidents or strenuous physical labor such as hauling water or carrying firewood. The remaining cases were related to a food or medication consumed or some other unidentified causes. One woman in San Antonio had her second miscarriage during our study. Her relatives blamed an unidentified pill that a politician had given out to her under the guise of medication during a campaign promotion.

Menarche

We asked the teenage girls whether they reached menarche. While there is only a small sample of girls this age in our sample, the average age of menarche falls around 12-13 years of age. Again, age estimates are not highly precise, but this provides a comparable number to other populations. Women and girls who are menstruating are forbidden from preparing food or *chicha*.

Selected Rates

I compared indicators of Tsimane' fertility in the two communities using information gathered during the reproductive histories, as well as our ongoing

demographic file. *Overall lifetime fertility* of a population is a measure of the total number of live births divided by the number of women of reproductive age. For our sample, overall lifetime fertility was calculated to be 5.1 children per woman (not age standardized). By comparison, the national fertility rate for Bolivia in 2001 was 4.1 (WHO 2001).

The *annual birthrate* for each community is calculated from the number of live births in 12 months over the mid-year population. I chose the period of June 1, 1999 to May 31, 2000 because it was the time when we have the best observational record in both communities. I calculated the sample mid-year population by taking the population during Quarter 2 of the panel study. During this period there were 12 births (7 females, 5 males) and a mid-year population of our sample of 144 in San Antonio, making the annual birthrate for San Antonio 8.3%. During this same time period in Yaranda, we have record of only four births (2 females, 2 males) and a mid-year sample population of 119, resulting in an annual birthrate of 3.3%.

The *infant mortality rate* is calculated as the number of infant deaths before the first birthday divided by the number of live births and then multiplied by 1000. The overall infant mortality rate for all reported lifetime pregnancies in the study was 134 per 1000 live births, 115/1000 in San Antonio, and 139/1000 in Yaranda. These community differences are not statistically significant ($Chi^2 = 0.42$; $P = 0.517$). During our actual research, there were no infant deaths recorded in Yaranda. In San Antonio three infants died during the first three months of our pilot research and a fourth died in January 2000. The national infant mortality rate for Bolivia is 56 per 1000 live births (United Nations

2001). In both communities, the infant mortality rate was more than twice that of the national average, reinforcing the need for improved reproductive and neonatal healthcare.

Chapter Summary

In order to provide the ethnographic descriptions of the Tsimane' relevant to this study, I have discussed general aspects of Tsimane' health based on research in the two study communities. Factors which contribute to the overall production of Tsimane' health include the tropical ecology in which they live, social and physical infrastructures, and available health-care services, both of traditional and modern foundations. This information helps put into context the analysis of the relationship between measures of integration to the market and acculturation affect Tsimane' health.

CHAPTER 6
MARKETS, ACCULTURATION, AND SELF-PERCIEVED ILLNESS

Introduction

In this chapter, I examine the relationship between markets, acculturation, and perceived health status. I am interested in examining whether there are patterns to illness accompanying increases in economic integration and acculturation. With greater exposure and acculturation to Western values and technologies, the health of indigenous peoples may be altered in either positive or negative directions. Health status and health-seeking behaviors also may change if integration results in expanded or reduced access to economic and social resources.

The effects of increased contact, acculturation, and economic integration on human health have been studied in different places. Authors have come to competing conclusions about how socioeconomic change influences health status. One of the potential benefits of economic integration and acquisition of greater human-capital skills is improved objective health status through access to better nutrition, knowledge about illnesses, improved housing, and a wider range of treatment options (Steckel 1995). At the same time, self-perceived health status may actually decrease (Godoy and Cardenas 1998) with integration into the dominant economic and cultural system, as raised expectations for better health are not met. Improved health status (either objective or perceived) might facilitate more intensive economic participation and involvement in the wider society. At the same time, poor health negatively influences an individual's ability to be economically productive (Benzeval and Judge 2001). The production of health is

tied to many other factors beyond social and economic resources including dietary intake, acquired or inherited individual immunity, and disease susceptibility (Behrman and Deolalikar 1988). An individual's health status can be thought of as "a 'cumulative' outcome of events over a long period of time" (Behrman and Deolalikar 1988:667). By examining the effects of acculturation and integration into the market on health status, researchers are able to better understand how these processes affect the health of members of native populations.

I begin the chapter with a discussion the literature on how acculturation and integration into the market economy relate to individual health status. I include a discussion of the methods used to measure the dependent variable (self-perceived health) and limitations they pose to the analysis. Next, I describe illness prevalence, duration, and severity among the Tsimane' people based on data from seven-day illness recalls. I present data from the panel study to test whether there are differences in self-perceived health status of children and adults associated with increased measures of integration into the market and acculturation. Finally, I discuss interpretations of the research findings.

Review of the Literature

Acculturation and Integration to the Market

Historically, shifts to sedentary lifestyles affect disease profiles of foraging groups (Armelagos 1990). The resulting greater population densities provide an environment where infectious disease can persist and hygiene is more difficult to maintain. With socioeconomic integration and acculturation, forager-horticulturalists may encounter rapid or sudden shocks to their health status through contact with new infectious diseases, loss of mode of subsistence, or increased population pressures (Coimbra et al. 2002; Lawrence et al. 1980; Wirsing 1985). Although we do not have any historical records of

Tsimane' health during their more nomadic periods, one could assume that the increased population densities associated with a less migratory lifestyle may have exerted a shift in disease type and frequency (cf. Barkey, Campbell, and Leslie 2001).

More recent acculturative forces might also shape the ways in which the Tsimane' experience and label illnesses (Goodland 1988) and use different treatments. In Chapters 3 and 4, I described the history of Tsimane' economic and social integration with the wider Bolivian society, emphasizing the degree of variation in levels of acculturation and degree of involvement in the market economy. We might expect that with greater acculturation into national society and more intensive participation in the cash economy, the health of the Tsimane' would show notable improvements, including better dietary intake, improved hygiene, and expanded access to health-care services. In the following section, I discuss measures of acculturation and market integration as they relate to health status. At the end of this section, I introduce my hypotheses about the relationship between acculturation, integration into the market, and self-perceived health.

Factors Affecting Health Status and Use of Treatments

Education

One of the observable benefits of acculturation to Bolivian society is greater formal educational opportunities for both women and men. In the case of the Tsimane' Amerindians, schools were established in their communities only within the past 30 years. Across cultures, education has shown a positive effect on individual health status by way of nutritional information, preventative health measures, improved skills in market activities, greater efficiency of work, and the ability to make decisions and cope with problems when they arise (Akin et al. 1985). Specific health-promoting behaviors

such as the boiling of drinking water and better hygiene practices are associated with more education.

Worldwide, maternal education is consistently found to be positively associated with child health status (Akin et al. 1985; Caldwell 1993; Phillips 1990). Women usually occupy the role of caregiver and manager of the domestic sphere and are therefore responsible for child hygiene, food preparation, and care of ill children. Educated mothers may be more aware of preventative measures and use them regularly, as well as educate their children about health in general (Akin et al. 1985). Studies have shown that less educated women are more likely to self-treat illness (Akin, Guilkey, and Popkin 1981 in Akin et al. 1985), even though self-treatment is almost always the first option for addressing ill health in general, regardless of education (Ryan 1998). As such, greater maternal acculturation should predict better child health status and greater use of health-care services when children are ill. Paternal education, in general, is linked to improved child health via improved economic opportunity available at higher levels of skill training and formal education (Caldwell 1993).

Education is highly related to income and socioeconomic status (Phillips 1990). Thus, the endogeneity of income and education makes it difficult to assess the independent effects of income or education on health. In Chapter 4, I demonstrated that Tsimane' women ranked lower on all measures of acculturation including language, literacy, and formal schooling compared to men. Tsimane' women also have significantly lower measures of integration into the market economy. Acculturation and integration almost certainly shape one another.

Education has also been associated with more frequent and effective use of health services (Phillips 1990). The education effect operates through improved communication with health providers, more compliance with treatment instructions, and a greater likelihood of using modern medical services (Phillips 1990). Knowledge of the national language can improve access to health-care services in urban areas where fluency is necessary to fully explain symptoms, interpret medical prescriptions, and navigate the bureaucracy often involved in accessing care. Language acquistion may also be associated with greater assimilation to the values and practices of the wider society. Lack of education acts as a barrier to seeking outside treatments to severe cases of illness. For instance, we observed that some Tsimane' adults were embarrassed by their poor ability to communicate in Spanish and repeatedly requested a common and familiar medication in pharmacies regardless of whether it was appropriate for the symptoms. In contrast, treatment by traditional healers does not involve navigating cultural borders.

Considering acculturation from a different perspective, the process of acculturation might result in poor perceptions of health relative to the wider society. The beneficial health effects of improved human capital such as education can be offset by the higher expectations for better health that often accompany acculturation (Godoy and Cardenas 1998). A greater awareness of health conditions that were not previously perceivable, such as diabetes and hypertension, might further lead to higher self-reports of illness (Murray and Chen 1992). Education overall, should have beneficial effects on objective health status and treatment of illness, but may predict poorer self-perceived health status especially for adults who do not meet raised expectations of improved health.

Income

Three ways in which income might affect health status include: level of income, composition of income, and temporal aspects of income. First, increased absolute income in general predicts an increase in consumption of goods and services, including health care (Akin et al. 1985), and may also improve nutritional status through the purchase of higher quality and more diverse foods. Income as a measure of market integration should be associated with greater use of health-care services, specifically modern biomedical services that are often more expensive. Even so, any positive income effect on health status may not be noticeable if there are no accompanying improvements in physical infrastructure (Kennedy 1994) or knowledge about disease transmission and preventative practices (Tomes 1999).

Second, the composition (cash or noncash) of income in a rural economy includes more than cash earnings. We saw in Chapter 4 that in-kind income and direct consumption of goods factor into the equation. Increased access to cash income can improve health if it is directed toward goods and services that contribute to improved nutrition, hygiene, and illness prevention. However, while observing Tsimane' participation in the market economy first-hand, I noted patterns of cash income disposal that might not stimulate any positive health effects. Cash income is easily directed toward the purchase of luxury items that do not directly improve health and may even impair health such as such as alcohol (Steckel 1995) and tobacco. We observed this behavior in our translators who would quickly spend their monthly salaries in town on luxury items, prepared meals, and even beer or alcohol. In contrast, typical in-kind payments include food staples that are bound directly toward household and individual nutrition. This leads to the suggestion that income in-kind might have a stronger effect

on household-health as this type of earnings typically transfers into direct investments in individual and household welfare.

Not much is understood about how the composition of income affects the use of health services. In a market economy, most health services and treatments are accessed through cash payment. Increased access to cash income would presumably take out the middle-step of having to liquidate wealth assets during shocks. Among populations with little access to cash income, the willingness of health practitioners to accept in-kind payments for services may be a factor that influenced individuals and households with fewer cash sources to seek these healers.

Costs associated with accessing health care go beyond nominal costs of treatments and services. Opportunity costs of using different treatments and transport costs are indirect costs that also affect decisions about which treatments to use. Some studies show that home remedies are the most frequent type of traditional treatment, citing that people operate under the logic of cost reduction (Akin et al. 1985; Reeve 2000; Ryan 1998). Even traditional healers incur an array of costs to the clients that might discourage their use. Greater access to income, in cash specifically, might enable people to opt for modern biomedical treatments rather than having to incur the indirect costs of searching for botanical remedies, preparing them, and even seeking treatment advice from others. These factors may overlap to affect perceived efficacy of different treatments options. With exposure and greater familiarity with Western concepts of health, more acculturated individuals may perceive the quality of modern health services as higher and therefore be more inclined to use them. In San Antonio, we noted that greater facility and learned

behavior of going to town for medications seemed to be a notable community difference based on greater acculturation, not just economic status.

Finally, temporal aspects of income come into play in mediating health. Long-term income has been shown to be more important than current income in determining health (Behrman and Deolalikar 1988). This suggests that smoother patterns of income over the long-term may be more beneficial than periodic spikes or dips in present income. Another factor that can affect investment in child health is whether income is earned and controlled by mothers or fathers. Even though women often control fewer economic resources, it has been repeatedly found that they direct a greater proportion of what they earn toward household needs (Mencher 1988).

Wealth

Material wealth can function as insurance against household and individual shocks such as illness. If assets are used over the lifetime to invest in household infrastructure, they might predict healthier members and less need for medical care (Akin et al. 1985). Yet, similar to income, greater wealth may influence perceptions of health leading to higher reporting of illness. International studies of self-perceived health status suggest that perceptions of overall health are tied to income levels (Akin et al. 1985), with higher income groups reporting more illness (Murray et al. 1992). A review of self-reports of illness showed that wealthier individuals in the United States reported more illness than lower income people in Ghana, Côte d'Ivoire, and Peru (Murray et al. 1992).

Methodological Notes

Measuring Health Status

Before I present my hypotheses on market integration, acculturation, and health status, it is important to understand how I operationalized health status in this study.

Medical anthropologists distinguish between illness and disease to establish broad definitions of each. *Disease* is understood as a "practitioner's construction of patient complaints in the technical terminology of a particular healing system" (Kleinman and Seeman 1999:231). In the case of Western biomedicine, this most often reflects structural and functional abnormalities to the body. By contrast, *illness* refers to the "culturally patterned social and personal elements of sickness" (Kleinman and Seeman 1999:231). This broad category of illness can include what constitutes disease as defined by a specific healing system in addition to other socially undesirable states.

There are many methods for assessing disease and illness status. Objective measures include clinical examinations, analysis of blood samples, and anthropometric assessment. Measures of disease are probably recorded better through observed morbidity than self-perceived morbidity (Murray and Chen 1992). Among the Tsimane', I collected information on individual health status using a seven-day recall of self-perceived illness. Self-reports give the researcher an idea of respondent's perception of their own, and in this research design, their children's illness state as well (Murray et al. 1992).

In choosing a seven-day recall, our team used a narrower window for recall than other studies. Young and Garro (1982) worked on a two-month recall period, asserting that they only missed minor ailments. Weller and colleagues (1997) relied on a three-month recall queued by a holiday in one sample and conducted monthly visits in another. By shortening the recall, we hoped to produce more accurate results (Bernard et al. 1984).

Limitations to Methods

There are several limits to using self-reports to measure health status. In part, what this method measures is the different sensitivities to illness (Behrman and Deolalikar 1988). In my study, parents reported information about the health of their children. When an individual reports on the health of another individual, they tend to report fewer cases of illness (Murray and Chen 1992). This could be a source of bias downward for the prevalence of child illness, duration, and severity. Other scholars have found a reluctance among respondents to disclose the use of traditional treatments to researchers because they do not want to appear "ignorant or backward" (Phillips 1990:187). Another potential bias exists is people become tired of the surveys and respond no to avoid further questioning. However we found no statistically significant increase in item nonrepsonses in the health survey from quarter to quarter. These potential limits and biases to the data limit the interpretation and comparability of self-report data to studies of other populations. There is also a risk of absenteeism that might miss the most severe cases where individuals have left the communities for extended treatment, such as tuberculosis. However, because our dates were randomly selected, we hopefully have avoided this bias.

Lag Time

Determination of appropriate lag times between measures of market integration and health outcomes is another methodological challenge. During four of the five quarters, both sets of researchers were consistent to lag the time between the collection of economic data and illness surveys by around a month. This translated into income being earned during a period between 30-60 days prior to the illness surveys. Quarter 4 is the anomaly in which the data collection schedule was compromised to a shorter lag time of

only two weeks in both San Antonio and Yaranda, making the economic data only 35 days prior to the health measures. In retrospect, this shorter lag for Quarter 4 is a consequence of the competing responsibilities of all our team members in the development and training of a team of surveyors to conduct our cross-section study.

Child versus Adult Populations

Child health status is recognized as a measure of the general health of a population (Goodman and Armelagos 1989). Within the field of international health, researchers and program managers have focused resources largely on improving child health in lower income countries. Some scholars point out that adult health in these regions of the world mandates equal attention (Feachem et al. 1992; Oths 1996). Nevertheless, adult and child health status depend on different factors. Child subsistence is dependent in large part on the income, human capital attributes, and decisions of parents or other adults in the household rather than on the child. In the analyses I present here, adults and children are considered separately. My models for adult health status focus on individual-level measures of economic integration and acculturation. Because parents are the primary health guardians of children, I use measures of household and parental market integration and acculturation in the models for child health status and treatment use rather than the child's own levels.

Hypotheses

Based on the literature about self-perceived health status, I developed two hypotheses about the effects of integration into the market and acculturation on native health status.

Self-Perceived Health Status of Adults

> *Hypothesis #1* Adults who are more acculturated and integrated into the market economy will report more illness, and will have longer and more severe illness episodes.

With this hypotheses, I examine indirectly whether the Tsimane' are at a point of economic and social integration that would enable them to achieve the perceived potential benefits to health. It is possible that even the most economically integrated and acculturated individuals in the sample are still not at a level at which they see notable improvements and they may complain more about illness because of raised expectations. Likewise, levels of cash income may not be high enough or steady enough to show a positive effect on perceived health.

As a marginalized population within Bolivia, the Tsimane' have no basic physical infrastructure or adequate access to health services. As they become more acculturated into the national society, expectations for better health status may rise. Minor ailments may become a greater source of complaint than before because they contradict an anticipated better health status that goes along with "modernization."

Economic integration may allow Tsimane' adults to take time out to be ill so they will report a longer duration of illness. Economic activities that lead to bulk income or stocks of wealth may provide a cushion during times of illness. A livelihood strategy that includes both market and subsistence activities might enable them to let farm activities wane for short periods. At the same time, individuals with lower measures of acculturation and integration into the market economy may have to maintain a higher threshold for reporting illness as they are not afforded the luxury of taking time away from traditional subsistence activities.

Self-Perceived Health Status of Children

Hypothesis #2 Children with more acculturated and market-integrated parents will have less reported illness, and shorter and less severe episodes.

Unlike adult perceived-health status, greater parental acculturation and market integration should be associated with improved child health status. I predict that because child health is sensitive to short-term change, short-term income and wealth may influence their status. Child health will be positively influenced by more acculturated parents who use those skills and knowledge to stave off illness, access treatment for ill children, and buffer the negative effects of illness shocks.

I use three measures of self-perceived health status to test both hypotheses: 1) prevalence of illness, 2) total days ill, and 3) total days confined to bed due to illness. Table 6-1 contains definitions of the measures of self-perceived morbidity collected during the illness surveys that serve as the dependent variables for testing my hypotheses. Before testing the above hypotheses, I present descriptive analysis of each measure.

Table 6-1. Definitions and measurement of dependent variables for health status

Variable	Definition
Self-Perceived Health	
Illness	Binary variable for reporting illness in last 7 days. [Reported at least 1 illness = 1; None = 0]
Total Days Ill	Total number of person days ill in last 7 days [0-15 days][15]
Total Bed Days	Total number of person days ill in bed in last 7 days [0-8 days]

[15] Maximum number of days ill and days in bed are greater than seven because of multiple illnesses on same person. Reported days reflect cumulative person days of all illness reported in a recall.

Descriptive Analysis of Tsimane' Illness

Illness Prevalence

During the surveys, subjects reported whether or not they had been ill, the type of illness, and any treatments used. Table 6-2 presents illness prevalence rates each quarter for adults and children combined by community to analyze possible seasonal patterns in addition to overall rates. The prevalence rate indicates the proportion of the sample that

Table 6-2. Comparison of illness prevalence rates for total sample and by community, (one observation per person per quarter; n = 1325)

Sample	n	Ill	Not Ill	Between Community Chi^2	p
Quarter 1 (Dry/Planting)					
San Antonio	130	62%	37%		
Yaranda	125	35%	64%		
Total	255	49%	51%	18.7	0.001
Quarter 2 (Wet/Preharvest)					
San Antonio	132	50%	50%		
Yaranda	127	37%	62%		
Total	259	44%	56%	4.44	0.04
Quarter 3 (Wet/Harvest)					
San Antonio	149	49%	51%		
Yaranda	116	47%	53%		
Total	264	48%	52%	0.20	0.66
Quarter 4 (Dry/Fishing)					
San Antonio	133	44%	56%		
Yaranda	122	39%	61%		
Total	255	42%	58%	0.66	0.42
Quarter 5 (Dry/Planting)					
San Antonio	161	47%	53%		
Yaranda	131	58%	42%		
Total	292	52%	48%	3.38	0.07
All 5 Quarters					
San Antonio	704	50%	50%		
Yaranda	621	43%	57%		
Total	1325	47%	53%	6.69	0.01

reported being ill in the seven-day recall period covered by the survey. The aggregate prevalence rate of self-reported illness over all five quarters was 47%. Comparing prevalence rates by community, the residents of San Antonio reported having been ill

significantly more than residents of Yaranda ($Chi^2 = 6.69$; $P < 0.01$). Residents of San Antonio reported illness at higher rates than Yaranda in all quarters except for Quarter 5 where we recorded the highest quarterly rate for Yaranda.[16] These community-level differences are statistically significant in Quarters 1 and 2 ($P<0.05$) and only moderately in Quarter 5 ($P<0.07$).

Table 6-3 shows that there are no significant differences in self-reporting of illness between adults and children ($Chi^2 = 1.53$; $P = 0.22$). Among adults, adult women reported illness (49%) significantly more than men (41%; $Chi^2 = 3.8$; $P < 0.05$). No statistically significant difference between illness prevalence of girls and boys as reported by their parents ($Chi^2 = 1.10$; $P = 0.29$) was detected.

Table 6-3. Comparison of illness prevalence rates by age category and gender (one observation per person per quarter; n = 1325)

Sample	n	Ill	Not Ill	Chi^2	P
Adults					
Women	307	49%	51%		
Men	305	41%	59%		
Total	612	45%	56%	3.82	0.05
Children					
Girls	339	51%	49%		
Boys	374	47%	53%		
Total	713	49%	51%	1.10	0.29
Between Children/Adults				1.53	0.22

Duration and Severity of Illness

Self-reports of the number of days ill and days confined to bed are subjective measures of functional disability (Murray et al. 1992) and restrictions on normal activities attributed to an ill state of health. These two measures proxy for duration and severity because they indicate an illness episode long enough to curtail normal activity.

[16] There might be coder bias, because during Quarter 5, Byron rather than Reyes-García administered the illness survey in Yaranda.

It is possible that subjects suffered from more than one illness during the seven-day recall period. Therefore, we assigned each illness and its corresponding treatments an entry in the data set. The maximum number of illnesses reported by any subject during a single survey was three. Only 9% of ill subjects reported having more than one illness during a single recall. When considering the burden of disease in the population, I am interested in the combined effect of multiple illnesses when I examine severity on a continuous scale. To account for subjects who reported multiple illnesses during the recall period, I summed the total number of days a subject reported being ill for all illnesses reported in a single survey. I did the same for days confined to bed. Thus, the maximum number of days ill is greater than seven (0-15 days). The reported values account for total person days, rather than actual days, because I cannot discern from the data whether these days were overlapping or not. Table 6-4 displays summary analysis of measures of duration and severity over all five quarters for persons reporting illness.[17]

Table 6-4. Summary statistics on illness duration- cumulative person days ill from all illness during the last 7 days

Variable	n	mean	median	SD	Min.	Max.	t-test	P
Adults								
Women	148	5.0	5	2.8	1	14		
Men	122	4.8	5	2.6	1	14		
Total	270	4.9	5	2.7	1	14	-0.79	0.43
Children								
Girls	173	4.5	4	2.9	1	14		
Boys	172	4.7	4	2.8	1	14		
Total	345	4.6	4	2.8	1	14	0.71	0.48
Total Sample								
San Antonio	352	4.9	5	2.8	1	14		
Yaranda	265	4.5	4	2.7	1	15		
Total	617	4.7	4	2.8	1	15	-1.67	0.09

[17] n = 624 ill people, but due to missing data on seven subjects, n = 617.

The maximum number of days ill was 15 days with an average of 4.7 days. I ran t-tests to compare illness duration between communities. There is only weak statistical support ($t = -1.67$; $P < 0.09$) of a difference between the two communities. At the aggregate level, people in San Antonio did not take any more time off to be sick than residents of Yaranda as I predicted. There are no substantively or statistically significant differences between average days ill between females and males, either adults or children (not shown).

The maximum number of days reported in bed was eight with an average of less than one (0.71) (Table 6-5). This summary suggests that people did not stay confined to bed when ill. There is little variance in measures of severity (median = 0, SD = 1.6) and the results show no statistically significant difference between communities ($t = 0.15$; $P = 0.87$).

Table 6-5. Summary statistics on illness severity, days confined to bed due to illness during the last 7 days

Variable	n	mean	median	SD	Min.	Max.	t-test	P
Adults								
Women	148	0.89	0	1.9	0	7		
Men	122	0.98	0	1.8	0	7		
Total	270	0.93	0	1.8	0	7	0.38	0.71
Children								
Girls	175	0.51	0	1.4	0	8		
Boys	173	0.56	0	1.4	0	7		
Total	345	0.54	0	1.4	0	8	0.33	0.74
Total Sample								
San Antonio	352	0.70	0	1.6	0	8		
Yaranda	265	0.72	0	1.6	0	7		
Total	617	0.71	0	1.6	0	8	0.15	0.87

Overall Pattern of Illnesses

During the pilot phase I began compiling a list of illness names in Tsimane', Spanish, and English. I assembled the list from existing sources (Mayer Roca and

Clemente Caymani 1999) and from interviews with residents in both communities. I appended this list throughout the study and further assigned numeric codes corresponding to each illness for data entry. During the interviews, our translators explained to us what name the illness would be in Spanish, and if no name was provided we wrote the name in Tsimane' and worked together on translating them at a later date. Once I returned from the field, I grouped the raw data into broad categories. Table 6-6 lists the most common categories.

There were a total of 685 illness episodes reported by 616 people, including multiple illnesses. These seven broad categories listed in Table 6-6 account for 91% of all illnesses. Table 6-7 includes the breakdown by subject group and gender. For the most part, the survey captured acute illnesses or symptoms. Overall, respiratory illnesses (31%) followed by gastrointestinal problems (21%) were the two most common types. Under the category of respiratory illnesses, I grouped common colds, coughs, throat problems, and tuberculosis. Gastrointestinal illness includes diarrhea, parasites, worms, vomiting, gall bladder pain, and generalized stomach aches. The third most common category was febrile illness (10%), which included all reports of temperature or fever. There is likely to be overlap between febrile and respiratory illness, as well as some

Table 6-6. Illness groupings by type

Illness Category	Illnesses reported
Respiratory illness	Coughs, colds, throat problems, tuberculosis
Gastro-intestinal	Diarrhea, parasites, worms, vomiting, gall bladder or stomach pain
Febrile	Fever, elevated temperature
Muscular-skeletal	Chronic or acute muscle, joint, leg, feet, or back pain, injuries to legs and feet
Head ailment	Headache, ear or eye problem
Dermatological	Burns, fungus, boils, blisters, rashes, botfly infections
Dental	Mouth and tooth pain

gastrointestinal reports. Conditions that fall into the "other" category (9%) include chest pains, measles, urinary tract problems, minor lacerations, reproductive problems, and spiritual illness.

Because children and adults may experience illness at different frequencies, I split the pooled sample between adults (age ≥15 years) and children (age <15 years). I further disaggregated by sex within each group. Respiratory illness is the most frequent complaint for both adults (26%) and children (35%). Gastrointestinal illnesses are the second most prevalent illness types for children (26%) and third (15%) for adults. Muscular-skeletal ailments were more concentrated in adults (20%) than in children (<1%). These results are consistent with colds and diarrhea being the most common problem for children living in a tropical environment. Looking at the two main illness types over the five quarters sampled, respiratory and gastrointestinal, there was no evidence of seasonality as I had expected.

Table 6-7. Most common types of illness/symptoms by categories from all illnesses reported over 5 quarters n = 685 illness episodes

	Children			Adults			
Illness Category	Girls n=195	Boys n=191	Total n=386	Women n=171	Men n=128	Total n=299	All Subjects n=685
Respiratory	35%	35%	35%	25%	27%	26%	31%
Gastrointestinal	27%	25%	26%	15%	15%	15%	21%
Fever	18%	12%	15%	2%	5%	3%	10%
Muscular-skeletal	0%	<1%	<1%	22%	19%	20%	9%
Head, Eye, and Ear	6%	7%	6%	12%	14%	13%	9%
Dermatological	7%	11%	9%	4%	7%	5%	7%
Dental	1%	4%	3%	8%	3%	6%	4%
Other	6%	5%	5%	12%	10%	12%	9%
Total	100%	100%	100%	100%	100%	100%	100%

Mortality

While they did not occur during the illness recall periods surveys, there were two adult deaths during our fieldwork and three infant deaths (discussed previously in Chapter 5). In San Antonio, one young adult male died from a self-inflicted shotgun wound to the abdomen during a marital dispute over his relationship with his wife's sister. In Yaranda, the deceased was an older man who had been ailing for some time. His family had tried to cure him by taking him to the healer in Cosincho. They also had taken him to the clinic at Horeb, all without success; he died in October 1999. Soon after, the surviving family proceeded to build a new house to live in so that the sprit of the deceased would not linger to bother them (Ellis and Aráuz 1998; Pérez Diez 1985). This practiced was observed many times in Yaranda after grave illness episodes of a household member such as measles.

Treatment of Illness

During the illness recall, our team recorded all reported treatments used during the last seven days. Out of the total 685 different self-reported illnesses recorded, 62% of them were treated at least once (Table 6-8). There was no significant difference in whether or not reported illness was treated between the two communities ($Chi^2 = 1.03$; $P = 0.31$). I also did not find any evidence of gender bias in treatment among adults or children.

Types of treatment

Specific treatments or services used were coded into 16 predetermined categories I developed during the preliminary research phase (Weller et al. 1997). Later, I further classified treatments into the binary variable of either "modern" (e.g., biomedical, pharmaceuticals, or hospital consultations) or "traditional" (e.g., home plant or animal-

based remedies or consultations with traditional healers). Table 6-9 summarizes the frequencies of initial treatments by type.

Table 6-8. Percent of all recorded illnesses treated by community and age category (n = 685 illnesses)

Group	n	Treated	Not-Treated	Chi^2	P
Community					
San Antonio	395	64%	36%		
Yaranda	290	60%	40%		
Both	685	62%	38%	1.03	0.31
Adults					
San Antonio	171	60%	40%		
Yaranda	128	60%	40%		
Both	299	60%	40%	0.00	0.92
Children					
San Antonio	195	64%	36%		
Yaranda	191	64%	36%		
Both	386	64%	36%	0.00	0.96
Between Children/ Adults		--	--	1.21	0.27

The Tsimane' people in our sample used modern treatments slightly more often than traditional treatments. There are similar patterns of using modern or traditional treatments in both communities. No statistically significant difference was detected in type of treatment (e.g. modern methods, traditional methods, or left untreated) (Chi^2 = 1.24; P = 0.54) between the communities. This finding contradicts the idea that distance is a barrier to accessing modern treatment. The difference in accessibility of treatments

Table 6-9. Comparison of illness treatment type by community

Type of Treatment	San Antonio %	(n)	Yaranda %	(n)	Total %	(n)	Between Community Chi^2	P
None	36%	143	40%	116	38%	259		
Traditional	28%	113	28%	82	28%	195		
Modern	35%	139	32%	92	34%	231		
Total	100%	395	100%	290	100%	685	1.24	0.54

*Initial treatment recorded

probably depends more on economic access (measures of integration) and social access (measures of acculturation), than in physical access and needs to be analyzed at the individual level. No significant difference was detected in use of modern or traditional treatments between females or males in the combined sample of adults and children.

Effect of research team's medical kit

Medications given by the research team accounted for 30% of all the modern treatments and 10% (not shown) of all treatment options (none, traditional, or modern). By percentage of the sample population, use of the researcher medical kit as an initial treatment was higher in Yaranda (36%) than in San Antonio (27%). While the kit introduced the bias of an additional biomedical option normally unavailable in either community, residents of San Antonio still opted to use the pharmacies to seek treatment more often than our medical kit. In both communities, the medical kit was used the most for initial treatments in the fifth quarter of the study, suggesting that the Tsimane' in the study communities were beginning to rely more on our research team as a source of health care.

When I look specifically at use of modern treatments, it is evident that the biggest effect our medical kit had on treatment utilization was for respiratory and gastrointestinal illnesses. If I drop out observations of illnesses treated by our medical kit, the results show that gastrointestinal illnesses are more often treated by traditional means, and when respiratory illness is treated, traditional treatments were used more than modern (figures not shown).

Hypothesis #1 Adult Self-perceived Health

In the next two sections, I present models used to test the hypotheses #1 and #2 and the corresponding results. I used three different dependent variables: 1) reported self-

perceived illness (Ill = 0,1), 2) duration (total days ill = 0-15), and 3) severity (total days in bed = 0-8). For the model for illness I ran repeated measures multiple logistic regression using logit techniques. I used repeated measures tobit regression analysis for the two models of continuous predictors (total days ill and total days in bed). Results from adult and child analyses are presented separately.

Multiple Logistic Regression Model on Self-Reported Illness (Logit)

I examine the probability of adults reporting an illness by measures of acculturation and integration into the market. The multiple logistic regression model analyzes the effect of independent predictors on the log of the odds of reporting an illness (1,0). The odds of success (Ill = 1) are the probability of success (π) over the probability of failure ($1-\pi$). The logistic transformation, or logit, formula uses the log of the odds to put probability estimates (π) on the log scale. The coefficients generated in the regression analysis (β_i), represent the multiplicative effect of an independent variable on the odds of success. In the present study, this translates into the change in odds of reporting illness as an independent variable changes, holding all other variables constant. For every one unit increase in an independent variable (e.g., 1 Bs. or 1% greater income (log transformed)), the odds of reporting an illness are multiplied by e^{β}. For ease of interpretation, odds ratios are reported in the tables rather than coefficients (see Appendix A for a summary of key concepts of the logit model and the interpretation of results).

Model 1 (Self-Reported Illness)

$$\text{logit}\,[\pi\,(\text{Ill})] = \alpha + \beta_1(\text{log income}) + \beta_2(\text{log wealth}) + \beta_3(\text{school grade}) + \beta_4(\text{Spanish}) + \beta_5\,(\text{community}) + \beta_6(\text{female}) + \beta_7(\text{age}) + \beta_8(\text{hhold size}) + \beta_9(\text{mean rainfall})$$

Model 1 examines individual measures of integration into the market economy through quarterly income and value of wealth assets. I used logarithmic transformations

of both economic measurements for ease of interpretation of results. Independent measures of acculturation include each adult's highest grade achieved in school and whether or not they speak Spanish (1,0). I selected highest school grade and oral competency in Spanish because they are not highly correlated with each other. I controlled for community of residence (1 = San Antonio, 0 = Yaranda), sex (1 = female, 0 = male), age, and household size. I included average daily rainfall (mm) in each community per quarter to account for seasonality and quarter of data collection.

I ran several variations of the model for logit [π (Ill)]. Results are displayed in Table 6-10. The estimated coefficients are reported as odds ratios (θ). Odds ratios greater than 1.00 indicate an increased multiplicative effects on the odds of reporting an illness. Odds ratios less than 1.00 indicate decreased multiplicative effects on the odds. An odds ratio equal to 1.00 predicts no effect, or independence.

Table 6-10. Odds ratios for the effect of market integration, acculturation, and control variables on adult illness (1 = Ill; 0 = Not ill)

Independent Variables	Model 1a	Women Model 1b	Men Model 1c	Factors Model 1d
Market Integration				
MI Factor				1.06
Log income	0.99	0.96	1.01	
Log wealth	1.09	1.05	1.14	
Acculturation				
Education Factor				0.98
Highest grade	0.98	0.75**	1.06	
Spanish	1.29	1.93**	1.06	
Controls				
San Antonio	1.01	0.87	1.03	1.07
Female	1.48*	--	--	1.29
Age	1.02**	1.01	1.02*	1.02**
Household size	1.04	1.03	1.01	1.03
Mean Rainfall	0.98	0.97	0.99	0.98
Subjects	147	73	74	141
Observations	589	300	289	571

*P<0.10; **P<0.05; ***P<0.01

Initially, I used individual measurements of total quarterly market integration on the entire sample of adults (n = 147 adults; 589 observations over five quarters). Results from Model 1a do not demonstrate any statistically significant partial effects of the measures of market integration or acculturation on the odds of reporting an illness. The only significant coefficients are for sex and age. The estimated odds ratio for sex is 1.48, that is, the odds of being ill (Ill = 1) are multiplied by 1.48 for women compared to the odds for men. The result can likewise be interpreted as the odds of reporting an illness are 48% greater for Tsimane' women than for men holding all other variables constant. However, the statistical significance of a gender effect is weak ($P<0.09$). With each additional year of age, the odds of reporting an illness increase by 2%, a small but highly statistically significant effect ($P<0.02$). No curvilinear relationship was detected between age and illness for adults, therefore I did not include a quadratic term for age.

Next, I tested for any significant interaction between gender and measures of acculturation or integration to the market. I found evidence of a statistically significant ($\theta = 0.77$; $P<0.02$) interaction between sex and schooling (interaction term = female*school grade) indicating that the effect of formal schooling on self-reporting of illness changes depending on whether the adult is female or male. This justified re-running Model 1a on women (Model 1b) and men (Model 1c) separately. Results presented in Table 6-10 indicate that schooling has opposite effects on the odds of reporting illness for women and men. Among women, each additional grade of school predicts a 25% decrease ($\theta = 0.75$; $P<0.02$) in the odds of reporting an illness. However, being a woman who can speak Spanish predicts a 93% increase ($\theta = 1.93$; $P<0.05$) in the odds of reporting illness. Among men, both schooling and competency in the national language have almost no to

only a small positive effect on the odds of reporting illness and these effects are not statistically significant.

The regression results from Models 1a-1c suggest that the measures of market integration may not display any partial effects on illness. The different proxy measures for market integration may instead act jointly to affect illness, rather than any one single variable having an independent effect. Therefore, I re-ran Model 1a substituting the factors of market integration and acculturation (cf. Chapter 4 for construction of factors) for the individual measures (Model 1d). The results do not suggest any significant effects of the factors representing integration and acculturation on the odds of reporting illness (Table 6-10). There was no evidence indicating an interaction between gender and market integration or acculturation in the factor model (Model 1d).

Repeated Measures Tobit Analysis of Duration and Severity of Illness

The dependent variables for duration and severity of illness are analyzed using repeated measures tobit regressions. In the analysis of duration (total days ill) and severity of illness (total bed days) any subject that did not report an illness will not have an observation for "total days" or "total days in bed." Their value for these two dependent variables is zero or left-censored. Running an Ordinary Least Square (OLS) regression model without the data from subjects who were not ill, will produce biased and inconsistent results. The coefficients from tobit analysis are read similar to coefficients from an OLS as the marginal effect of an independent variable on the dependent variable, holding all other independent variables at a constant value.

Duration of Illness

I ran a tobit model (Model 2) on the total number of days ill (total days ill) to assess the marginal effect of measures of market integration and acculturation on duration of

illness, another proxy for self-perceived health. Results from the analysis of illness duration appear in Table 6-11.

Model 2 (duration of illness)

$$\text{tobit}[\text{TotalDaysIll}] = \alpha + \beta_1(\text{log income}) + \beta_2(\text{log wealth}) + \beta_3(\text{school grade}) + \beta_4(\text{Spanish}) + \beta_5(\text{community}) + \beta_6(\text{female}) + \beta_7(\text{age}) + \beta_8(\text{hhold size}) + \beta_9(\text{mean rainfall})$$

Table 6-11. Coefficient from tobit analysis of the effect of market integration, acculturation, and control variables on duration of adult illness (total days ill)

Independent Variables	Model 2a	Women Model 2b	Men Model 2c	Factor Model 2d
Market Integration				
MI Factor				0.14
Log income	-0.08	-0.12	-0.08	
Log wealth	0.21	-0.01	0.38	
Acculturation				
Education Factor				-0.29
Highest grade	-0.14	-0.97***	0.15	
Spanish	0.38	1.64*	-0.39	
Controls				
San Antonio	0.28	0.01	0.23	0.32
Female	1.02	--	--	0.89
Age	0.06	0.04	0.07**	0.06***
Hhold size	0.02	-0.05	0.00	0.00
Mean rainfall	-0.05	-0.06	-0.02	-0.06
Constant	-4.22	-0.35	-5.77	-0.69
Subjects	147	73	74	141
Uncensored Obs.	265	146	119	258
Left-censored Obs.	319	153	166	308

*P<0.10; **P<0.05; ***P<0.01

I found no significant effects of measures of integration to the market or acculturation on duration of illness (Model 2a). Only the coefficient for age ($\beta = 0.06$; $P<0.01$) had any statistical reliability. Older adults are predicted to report longer duration of an illness. I tested for any interaction between gender and measures of market integration and acculturation. A significant interaction between gender and schooling in

the model of illness duration ($P<0.01$) was detected. Results from separate models for women (Model 2b) and men (Model 2c) imply that education has a statistically significant effect on shortening duration of illness among women. Each additional grade of schooling is associated with one day less of the total illness duration reported by women ($\beta = -0.97$; $P<0.01$). Spanish competency predicts longer illness duration by 1.64 days among women. The effect is moderately statistically significant ($P<0.07$). There is not evidence of a significant education effect on men's reported duration. Results (not shown) from the tobit on duration by factors of market integration and acculturation do not suggest any statistically significant relationship with duration of illness.

Severity of Illness

The third dependent variable for adult self-reported health status is the total number of days in bed due to illness, a proxy for severity. Model 3 examines the effect of measures of market integration and acculturation on illness severity reported by adults.

Model 3 (Severity of Illness)

$$\text{Tobit[Total Bed Days]} = \alpha + \beta_1(\text{log income}) + \beta_2(\text{log wealth}) + \beta_3(\text{school grade}) + \beta_4(\text{Spanish}) + \beta_5(\text{community}) + \beta_6(\text{female}) + \beta_7(\text{age}) + \beta_8(\text{hhold size}) + \beta_9(\text{mean rainfall})$$

Results from tobit analysis of severity are presented in Table 6-12. There is a significant interaction between gender and schooling (female*highest grade = -0.98; $P<0.04$). Similar patterns of significant associations between women's schooling and language ability only are evident. Women's schooling predicts less time ill in bed ($\beta = -1.36$; $P<0.01$). However, the sample of uncensored observations decreases when the samples are split and therefore these results should be interpreted with caution. Again, there is no evidence that measures of adult integration to the market are statistically associated with severity of illness.

Discussion of Adult Results

I did not find any strong support for Hypothesis #1, that more market-integrated adults report more illness. The absence of any statistically significant relationship between market integration and health will be discussed at the end of this chapter. The only statistically significant acculturation effects were apparent through education and language for women. To summarize, the analyses of Models 1-3 suggest a gender difference in the importance of schooling on adult self-perceived health. More formal education among women is related to lower odds of reporting illness and shorter duration and severity of illness. Among women, Spanish competency is related to greater odds of reporting an illness.

Table 6-12. Coefficients from tobit analysis of the effects of market integration, acculturation, and control variables on severity of adult illness (total number of days ill in bed)

Independent Variables	Model 3a	Women Model 3b	Men Model 3c	Factor Model 3d
Market Integration				
MI Factor				0.40
Log income	-0.10	-0.17	-0.03	
Log wealth	0.39	0.31	0.33	
Acculturation				
Educational Factor				-0.33
Highest grade	-0.11	-1.36***	0.26	
Spanish	-0.12	1.19	0.02	
Controls				
San Antonio	-0.14	-1.32	0.35	-0.13
Female	0.04	--	--	0.27
Age	0.05	-0.00	0.08*	0.04
Hhold size	-0.11	-0.24	-0.03	-0.11
Mean rainfall	0.06	0.12	0.00	0.07
Constant	-9.78	-5.76	-11.9	-7.81
Subjects	147	73	74	141
Uncensored Obs.	77	39	38	75
Left-censored Obs.	507	260	247	491

*P<0.10; **P<0.05; ***P<0.01

Hypothesis #2 Child Perceived Health Status

To test Hypothesis #2, I used the same three dependent variables but substituted parental and household measures of market integration and acculturation as the key independent variables. I include the same control variables as in the adult models. In this section, I present results and interpret statistically significant findings related to effects on child health.

Logit Model for Child Illness

Model 4 (Reported Illness for Children)

$\text{logit}\,[\pi\,(\text{Ill})] = \alpha + \beta_1(\text{log mom income}) + \beta_2(\text{log mom wealth}) + \beta_3(\text{log other income}) + \beta_4(\text{log other wealth}) + \beta_5(\text{momgrade}) + \beta_6(\text{dadgrade}) + \beta_7(\text{community}) + \beta_8(\text{female}) + \beta_9(\text{age}) + \beta_{10}(\text{hhold size}) + \beta_{11}(\text{mean rainfall})$

Results from the logit model on reported child illness are presented in Table 6-13.

Table 6-13. Odds ratios for effects of parental market integration, acculturation, and control variables on child illness (1 = Ill; 0 = Not Ill)

Independent Variables	Maternal Income Model 4a	Household Income Model 4b	Factor Model 4c
Market Integration			1.09
Log mom's income	0.99		
Log other hhincome	0.96	1.13	
Log mom's wealth	1.10		
Log other hhwealth	1.08	0.96	
Acculturation			
Momgrade	0.98	1.00	
Mother's Acculturation Factor			0.96
Dadgrade	1.13***	1.12***	
Father's Acculturation Factor			1.20*
Controls			
San Antonio	1.78***	1.92***	1.79***
Female	0.97	0.98	1.07
Age	0.88***	0.88***	0.88***
Household size	0.92**	0.91**	0.90***
Mean Rainfall	0.98	0.98	0.98
Subjects	165	181	181
Observations	656	689	668

*P<0.10 **P<0.05; ***P<0.01

No significant interactions between gender and measures of parental acculturation or integration to the market were detected, therefore I ran the models only on the pooled sample of girls and boys. In Model 4a, income and wealth are disaggregated to represent the income and wealth of the child's mother separate from the income and wealth of the remaining adult members of the household. This allows for the specific analysis of any partial effect of measures of maternal integration to the market. Contrary to trends in the literature on child health, I did not find evidence of an effect of mothers' individual income or wealth on the odds of child illness.

Maternal and paternal education have opposite effects on the odds of a child being ill. Higher paternal education predicts a small increase in the odds of illness ($\theta = 1.13$; $P<0.01$). Each additional grade of schooling of the father predicts a 13% increase in the odds of illness. The model only captures the highest school grade of each parent and might neglect the effect of other training or knowledge related to child health status. The community effect is highly significant. Children living in San Antonio are predicted to have greater odds of illness than children in Yaranda ($\theta = 1.78$; $P<0.01$). There is also a significant effect of age on child illness. The odds of reporting illness for a child decrease with age of the child ($\theta = 0.88$; $P<0.001$). Young children are at higher risk of illness than older children.

Given the absence of any evidence of a statistically significant relationship between measures of maternal market integration and child illness, I re-ran the logit model using total household measures of income and wealth. Results from Model 4b using only total household-level measures of market integration show a similar pattern of father's education relating to higher odds of reporting child illness ($\theta = 1.12$; $P<0.01$).

Finally, I explored possible combined effects of measures of acculturation and integration to the market, substituting factors for individual measures (Model 4c). Two distinct factors, one of mother's education and one of father's education result from principal components analysis of literacy and school grade. There is no evidence of any statistically significant effects of the factors of household market integration or parental acculturation.

Tobit Models

Duration of Child Illness

Model 5 tests the relationship between measures of market integration and acculturation on duration of child illness, measured by the total number of days reported ill within the last week. Table 6-14 shows that none of the coefficients for measures of income are statistically significant on the model run by maternal measures (Model 5a), total household measures (Model 5b), or factors (Model 5c).

Model 5

$$\text{Tobit[Days ill]} = \alpha + \beta_1(\text{log mom income}) + \beta_2(\text{log mom wealth}) + \beta_3(\text{log other income}) + \beta_4(\text{log other wealth}) + \beta_5(\text{momgrade}) + \beta_6(\text{dadgrade}) + \beta_7(\text{community}) + \beta_8(\text{female}) + \beta_9(\text{age}) + \beta_{10}(\text{hhold size}) + \beta_{11}(\text{mean rainfall})$$

There is only weak support for a statistically significant interaction between gender and maternal wealth (female*momwealth = 0.82; $P<0.08$). When I split the sample between girls and boys and re-run Model 5a only faint support of an effect of mother's wealth on girls duration of illness results ($\beta = 0.60$; $P<0.09$; results not shown). A one percent increase in maternal wealth predicts longer illness for girls by over half a day.

Father's schooling is associated with longer illness in Models 5a and 5b ($P<0.05$). Residence in San Antonio is associated with longer duration of reported illness ($P<0.01$).

The coefficient for household size is statistically significant in predicting shorter duration of illness (P<0.01).

Table 6-14. Coefficients from tobit analysis of the effect of market integration, acculturation, and control variables on child illness duration (total days ill)

Independent Variables	Maternal Model 5a	Household Model 5b	Factor Model 5c
Market Integration			0.30
Log mom's income	-0.03		
Log other hhincome	-0.04	-0.07	
Log mom's wealth	0.14		
Log other hhwealth	0.19	0.34	
Acculturation			
Momgrade	-0.11	-0.05	
Mother's Accult Factor			-0.23
Dadgrade	0.25**	0.20**	
Father's Accult factor			0.25
Controls			
San Antonio	1.69***	1.67***	1.49
Female	-0.20	-0.17	0.02
Age	-0.35***	-0.36***	-0.37***
Household size	-0.26***	-0.26***	-0.31***
Mean Rainfall	-0.06	-0.05	-0.07
Constant	1.25	1.01	4.18
Subjects	165	181	181
Un-censored observations	312	330	316
Censored Observations	342	357	350

* P<0.10 ** P<0.05; *** P<0.01

Severity of Child Illness

Model 6

Tobit[Days ill in bed] = $\alpha + \beta_1$(log mom income) + β_2(log mom wealth) + β_3(log other income) + β_4(log other wealth) + β_5(momgrade) + β_6(dadgrade) + β_7(community) + β_8(female) + β_9(age) + β_{10}(hhold size) + β_{11}(mean rainfall)

All variations of Model 6 demonstrate a similar effect of maternal education associated with less time ill in bed. Paternal education appears to have the opposite effect on severity of child illness. Father's schooling was highly associated (P<0.01) with a

half day longer in bed for children in Model 6a and Model 6b. The opposite effect of parental education is be discussed in the chapter summary.

Results for the analysis of severity of illness need to be interpreted with caution because the sample of uncensored observations is very low (n = 66) compared to the total number of observations on children over five quarters. Only 66 children were reported to have stayed in bed one or more days. Consistently, parents in San Antonio reported that their children spent longer periods in bed due to illness ($P<0.05$). The effect of measures of market integration on child heath are unclear. It appears that maternal wealth might be associated with more severe illness while household wealth may have a small negative effect on the number of days a child was sick in bed.

Summary of Child Illness

Results are mixed for the testing of Hypothesis #2 on child health. My results did not provide support for any relationship between measures of wealth or income and reported child health status. However, the results across all three models suggests that father's education is associated with greater odds of reporting illness and greater severity. I found a consistent pattern of maternal education predicting less severe illness episodes measured by reported number of days a child stayed in bed due to illness. Results on child severity may not be robust due to the small sample size.

Table 6-15. Coefficients from tobit analysis of the effects of market integration, acculturation, and control variables on child illness severity (total days ill in bed)

Independent Variables	Maternal Model 6a	Household Model 6b	Factor Model 6c
Market Integration			0.28
Log mom's income	-0.07		
Log other hhincome	0.13	-0.01	
Log mom's wealth	0.81*		
Log other hhwealth	-0.25	0.42	

Acculturation			
Momgrade	-0.92**	-0.81**	
Mother's Acculturation Factor			-0.95*
Dadgrade	0.50***	0.42***	
Father's Acculturation factor			0.75*
Controls			
San Antonio	1.72**	1.58**	1.90**
Female	0.32	0.58	0.66
Age	0.14	0.12	0.15
Household size	0.04	-0.08	-0.07
Mean Rainfall	0.01	0.04	0.05
Constant	-12.64	-12.10	-9.43
Subjects	165	181	181
Un-censored observations	63	66	60
Censored Observations	591	621	606

*P<0.10; **P<0.05; ***P<0.01

Chapter Summary and Interpretations

Contrary to the research hypotheses, results from the analysis did not find support for an association between measures of market integration and adult or child reported illness. The lack of association between measures of economic participation are unexpected. Evidence of acculturation effects are discussed below.

Adult Education and Acculturation

The finding of an opposite association between women's schooling and language competency is unexpected. It seems counterintuitive that one measure would relate to improved health perceptions and another to worse measures of health. Possible interpretations lie in consideration of what the two variables, schooling and language, represent. The highest school grade studied by an adult Tsimane' woman represents involvement in the formal educational system some time within the last 10-30 years. Schooling may have taken place entirely in Tsimane' communities and not in bilingual schools. Many Tsimane' adults acquired their language competency in Spanish not through formal schooling, but through direct and more frequent contact with Spanish

speakers in economic and social activities. In a sense, the variable for Spanish ability is probably capturing greater association with elements of the national culture. There is always the possibility that better competency in Spanish enabled the participants to better communicate with the researchers and lead them to report more illness during the recalls.

Adult Market Integration

Contrary to Hypothesis #1, I did not find any statistically significant effect of individual income or wealth on adult illness. It is possible that the research design overlooked important intermediate variables that better explain the effects of income and wealth on adult health. Economic integration and more education may not be enough to improve health status without concomitant improvements in the physical infrastructure of either community.

Acculturation and market integration may not operate together to affect self-perceived health status. The literature tends to discuss both processes as if they are interrelated, but in a population like the Tsimane' where levels of both measures are low relative to the national society, it prompts us to question whether members of the population are equally experiencing these influences.

Child Illness

I did not find support of any statistically significant associations between child health and measures of market integration as stated in Hypothesis #2. However, the results imply a significant association between parental education and child health. Parental education acts in opposite directions on child health. While paternal schooling was consistently related to greater odds of illness, longer duration, and more severe illness, maternal schooling was associated with less illness severity. I expected a larger and positive effect of maternal education, but the relationship between paternal education

is uncertain as to how this might mediate child health. Fathers with more education may be spending their income on other things such as market items or luxuries rather than on health-benefiting goods.

The models for child self-perceived illness, duration, and severity suggest a consistent community effect. Children living in San Antonio have greater odds of their parents reporting illness than their counterparts in Yaranda. After controlling for differences in measures of market integration, acculturation, and gender, there was still an association of greater reports and longer duration and severity of illness for children in San Antonio. This finding supports Hypothesis #2 if we assume that parents and households in San Antonio are more acculturated via exposure and proximity to town. In Chapter 8, I compare this effect on measures of nutritional status to explore dynamics behind community differences in another measures of child health. There are many unobserved differences between the two communities that our study may not have captured.

Conclusion

In each of my hypotheses, I bracketed the effects of acculturation and market integration. The results from the multivariate regression analysis present a more compartmentalized effect of the two processes. The analyses of adult and child self-perceived health status suggest that acculturation and economic integration may have different effects. Human capital improvements through acquisition of educational skills may not be sufficient to positively affect health status. Without any physical capital improvements, such as community infrastructure and improved access to preventative practices, education, income, and wealth may not be enough to distinguish individuals by their perceived health status.

The absence of any integration effects suggests that perhaps household and individual income are not invested directly into health benefiting goods and services (Haddad et al. 2002). Chapter 5 established the poor quality of services and deficiencies in health infrastructure in either community. Constraints to improved health such as poor water quality, intermittent vaccination coverage, and obstacles to accessing modern health care may not be overcome by the level of incomes available to Tsimane' households.

CHAPTER 7
MARKETS, ACCULTURATION, AND DIET

Introduction

Dietary change among indigenous populations undergoing acculturation and market integration is a concern to anthropologists because of our interest in how economic transitions impact traditional subsistence strategies. Changes in the way a population procures its food resources can affect the overall welfare of individuals and households in that population. While unique ecological and geographic circumstances strongly influence the specific composition of traditional diets, the changes associated with a shift from traditional foods toward greater reliance on market foods are strikingly similar across populations. Traditional diets are defined here as diets made up of plant and animal foods harvested from the local, natural environment (Kuhnlein and Receveur 1996). Shifts away from traditional foods can be attributed to a variety of factors including environmental degradation, land insecurity, market expansion, forced resettlement (Wilkie 1989), ecological constraints (Carneiro 1974; Shell-Duncan and Obiero 2000), settlement (Fratkin et al. 1999), migration, urbanization, modernization (Latham 1997; Ohtsuka 1993), willing participation (Henrich 1997), and colonization schemes (Ventura Santos and Coimbra 1996).

In the Amazon region, dietary change is being fueled by encroachment on indigenous lands, new employment opportunities with frontier expansion, national colonization schemes, and demand for cash cropping. The Tsimane' have been undergoing similar patterns of dietary alteration as other Amazonian groups throughout

the last century as subsistence economies are increasingly affected by these external influences. Like most other tropical populations, the Tsimane' do not earn their subsistence exclusively from the hunting and gathering of wild resources, but rather through a multidimensional strategy of wild, cultivated, and more recently, purchased foods. The introduction and availability of market-derived food resources have influenced the traditional diet as well as shaped the values the Tsimane' place on certain foods. Also, with integration to market the Tsimane' have incentives to sell protein rich foods (game, rice, maize) a potentially detrimental activity for household diets. Likewise, increased economic opportunities present the potentiai for accessing supplementary food resources in a region characterized by seasonal fluctuations in availability of wild and cultivated food resources. It is unclear whether the dietary changes associated with market integration are generally beneficial to integrating populations such as the Tsimane' or erode dietary diversity and quality.

Dietary transition in the Amazon associated with integration into the market economy has not been extensively studied. Most research combines assessment of nutritional status and dietary patterns (Dufour 1992; Dufour 1994; Hill et al. 1984; Hurtado and Hill 1990; Johnson and Behrens 1982) but does not analyze these variables with measures of acculturation and integration into the market economy. Many dietary studies only follow a few households within a single village and generalize about the wider population (Behrens 1986; Flowers 1983; Forline 1997). There exists a body of research quantifying the dietary intake of populations moving from greater reliance on hunting and gathering to higher dependency on agriculture and purchased foods (cf. Cordain et al. 2002; Kaplan et al. 2000 for summary of findings). However, these studies

focus more on ecological adaptation and reconstruction of the hunter-gatherer diet than on the analysis of socioeconomic factors to dietary change. Measures of both acculturation and integration into the market have not been jointly employed in quantitative analysis of dietary change in the Amazon. The dietary consequences of greater contact, exposure, and assimilation into an external cultural system are not well understood. Similarly, the manner in which increased articulation, participation, and dependency on the market economy affects traditional diets remains uncertain.

In this chapter, I look specifically at how differences in household measures of integration into the market and acculturation relate to several aspects of diet. Incorporation of forager-horticulturalists into a market-oriented economy may occur at different rates, and any beneficial outcomes may not be evenly shared by members of the acculturating group (Messer 1989). I begin with a discussion of relevant literature on economic change and dietary transition among indigenous peoples. I consider several aspects of dietary intake related to markets and acculturation. Next, I provide a summary analysis of Tsimane' diet including source of foods, dietary diversity, and seasonal patterns of diet composition. I assess whether there are qualitative and quantitative differences in the Tsimane' diet associated with variation in levels of integration and acculturation within the household. By analyzing measures of household diet in a multivariate framework, I analyze whether Tsimane' households that are more acculturated into Bolivian society and integrated into the market economy consume more foods originating in the market compared to less integrated households.

Integration to the Market Economy, Acculturation, and Diet: A Review of the Literature

Throughout evolutionary history, changes in subsistence mode have been accompanied by changes in human diet and nutritional status. Alterations in the availability of food resources and nutritional content of the diet are two possible consequences of these transformations. Subsistence transition may not affect all populations in the same ways, but vary by location and time. Comparative studies of living populations undergoing changes in their mode of subsistence contribute to our understanding of how dietary transitions vary and whether or not these transitions are advantageous or detrimental to dietary health.

Several Aspects of Diet

This dissertation is concerned with subsistence transition of households in a foraging-horticultural economy toward greater participation in the wider market economy. Whiting and Mackenzie (1998) have argued that there is not sufficient available information on dietary transition from traditional to market-based diets to understand its impacts on the health of indigenous peoples. There is not enough conclusive evidence to judge whether integration into the market improves indigenous diets by expanding choice and access to nutritionally better foods, or whether the process of acculturation and economic integration leads to declines in household dietary intake. In part, this lack of good information is because market integration and acculturation affect different aspects of diet. There are often changes in source, diversity, nutritional content, availability, and social value of food resources as a result of increased integration into the market economy. These five components of overall diet are

interrelated and I discuss each component below and present what is known about how it relates to dietary modification fueled by acculturation and integration.

Source of dietary resources: Toward greater reliance on market foods

In many regions of the world, a shift from subsistence production to commercial acquisition of food has occurred. As households increase their participation in the market economy and thereby their access to cash income, a pattern of increased consumption of purchased foods emerges. Changes in economic activities and time allocation affect the sources from which dietary resources are acquired. Competing demands for labor in the market economy can result in decreased time allocated to basic subsistence activities, for example, pulling the labor of forager-horticultural households away from subsistence production of food staples or from time spent hunting and collecting forest resources (Behrens 1992; Putsche 2000). The market then becomes an alternate source of food as home production or wild procurement declines.

Despite increasing participation in the market economy, market food resources may not be equally economically accessible to newly integrating households. Price poses an obstacle to accessing foods from the market. For example, research on Amerindian households intensifying cash cropping activities reveals that as consumption of wild meat declines, domesticated meat sources may be turned to as substitutes (Behrens 1986). But substituting for wild game entails either raising farm animals or purchasing or trading for meat in the market economy. Often, the culturally preferred high quality protein sources, namely meats, are expensive compared to nonmeat sources. Market prices for meat may present a constraint to recently integrating households. In a study of the influence of meat prices on the consumption of hunted game, Apaza and colleagues (2002) found a strong positive correlation between the market price of beef and the continuance of

consumption of game and fish. Market foods, in general, may also entail higher prices due to transport costs from distant origins of production. In the Amazon, long distances and poor transportation infrastructure linking consumers and producers of manufactured items drives up prices. Income from sales and wage labor must be sufficiently high to access market-traded foods.

Diversity of foods

Dietary diversity, or the number of different foods consumed in the diet, has long been thought to be a key element to balancing traditional diets (Kuhnlein and Receveur 1996). Consumption of a wider variety of different kinds of foods leads to better nutrition than a monotonous diet (Messer 1989). In general, greater diversity of diet is related to wider exposure to micronutrients and is viewed as a positive feature of health (Wirsing 1985). An increasing proportion of daily dietary intake from nontraditional origins can affect the diversity of foods consumed by households.

A positive relationship between income growth and the ability to purchase more food is widely accepted (von Braun et al. 1994). But this relationship is complex because as incomes rise, households generally exhibit a shift to more expensive food items (Bouis 1994; Kennedy 1994) that do not necessarily produce a net increase in diversity or quantity. In Peru, Leatherman (1994) found that while dietary diversity increased with access to market income, the nutritional value of the diet decreased as a result of replacing home produced foods of high nutritional value with higher calorie market substitutes lower in nutritional content. Also, the effects may not be equal across socioeconomic levels. Poorer families had lower diversity scores and fewer high quality market foods, especially during the lean season (Leonard 1989; Leonard and Thomas 1988). Integration into the market may lead to a shift away from the use of farm

resources while only a limited number of market foods are available as supplements or substitutes for traditional diet.

Beyond diversity, the types of food in the diet need to be examined to determine whether overall content of the diet declines with integration. Thus, even if market foods are accessible, those incorporated into traditional diet may have lower nutritional value.

Nutritional content of diet

Modern tropical foragers are a useful example for illustrating the general process of dietary change accompanying subsistence change. A foraging diet is typically high in protein, fiber, and carbohydrate of vegetable origin while low in sugar and saturated fats (Cordain et al. 2000; Cordain et al. 2002; Dufour 1988; Dufour 1992; Eaton and Konner 1985). As foraging groups shift subsistence practices toward the cultivation of food and domestication of animals, qualitative and quantitative changes occur in the macronutrient content of their diet. The composition of food resources is altered with the domestication of plants and animals. The body composition of domesticated animals differs from wild game with a generally higher fat ratio.

Tropical farming diets include crops high in bulk, but low in nutrients. Many starchy tropical crops such as manioc, sweet potatoes, and plantains are effective sources of energy (calories) because of the high proportion of carbohydrate, but poor sources of protein. This is particularly significant to the dietary intake of small children who risk filling up in volume before they meet their protein requirements (McElroy and Townsend 1996). In a review of literature on diet and nutrition in the Amazon, Dufour (1994) found the diet of native Amazonians to be high in bulk with 76% of energy derived from manioc or plantains. Animal sources accounted for the majority of dietary protein (68%).

A greater reliance on cereals grown on the farm has been shown to result in lower absorption of key nutrients such as iron (Cohen 1989).

Similar patterns have been documented among acculturating forager-horticulturalists groups such as the Tsimane'. Items available only in the market such as refined sugar, salt, alcohol, and pasta have been introduced and incorporated into the diet. What remains ambiguous is whether these changes have any significant impact on the nutritional quality of the diet. Market foods may erode or improve dietary quality if the new foods make different nutritional contributions than traditional foods. Understanding whether market substitutes are detrimental or beneficial to consumers depends on the nutritional adequacy of substitutes (Messer 1984).

Ventura Santos and Coimbra (1996) found negative impacts on dietary patterns and nutritional status with the abandonment of traditional subsistence in favor of market-oriented production in the Brazilian Amazon. Economic transition led to the consumption of calorie-rich industrial products such as refined sugars, pasta, crackers, soft drinks, canned sardines, and candies. These researchers even observed Suruí meals devoid of any garden or forest products. On the other hand, market foods may offer adequate nutritional substitutes for traditional foods and denote only categorical changes in diet.

Market income may also be insufficient to adequately substitute traditional foods with nutritionally valuable market foods. If this is the case, then the base of dietary consumption may still hinge on management of farm and forest resources with market foods contributing less to diet. There is some evidence that households are best off when

they maintain some home production in addition to market activities (Dewey 1980 in Messer 1989).

Seasonal availability of food resources

Little attention has been devoted to seasonality in Amazonian diets (Dufour 1992; Hurtado and Hill 1990; Hill et al. 1984). Most regions of the Amazon have distinct wet and dry seasons affecting the availability of edible plant and faunal resources (Headland and Bailey 1991). While staples such as manioc and bananas do not vary as much, seasonal availability of fish and game may result in fluctuations in available sources of protein. Likewise, rice and maize are harvested according to the annual cycle resulting in periods of abundance immediately following the harvest and scarcity in the preharvest season.

Seasonality is an important issue for populations that may experience cyclical dietary vulnerability rather than constant food stress. Researchers have examined seasonal reduction in dietary intake as a predictable, annual process (de Garine and Koppert 1990; Hurtado and Hill 1990). Across time, we can look at seasonality and the prevalence of vulnerable periods of protein consumption for example. Seasonal hunger is often evident through the consumption of less desirable foods in this period and more complaints of not eating highly valued foods such as meat (de Garine and Koppert 1990; Pasquet et al. 1993).

Comparisons of seasonal differences in foraging diets with farm diets have shown differences in availability of resources. Hill and colleagues (1984) found seasonal variability in content of diet but not in overall caloric intake among the Ache of Paraguay. They also found little variation in meat consumption, the most important resource for the Ache, throughout the year. Rather than a lean period, they found a "fat"

period where seasonal availability of honey in the beginning of the warm/wet season boosted caloric intake.

Agriculture is one proposed means of shoring up seasonal deficits of wild foods but vulnerability to crop loss exists. Flowers (1983) examined the transition from hunting-foraging to agriculture in Brazil to explore whether agriculture provided a more stable diet. She found no evidence that reliance on agriculture is associated with a more stable food supply, and in fact observed more seasonal vulnerability in crop-based diets (her small sample of households cautions the broad application of the finding). This conclusion of less fluctuation in food supply among hunter-gatherers has been found elsewhere with links to population size factoring into the equation (Brown 1985).

Similarly, we can examine whether the transition to greater market-based activities provides a more constant source of food than a diet based largely on the foraging of wild resources and farm production. Arguments in favor of markets benefiting dietary intake suggest a more secure source of resources year-round. Increased integration into national economic systems of exchange and acculturation can potentially result in greater access to income and thus purchased foods (Dennett and Connell 1988; Holmes 1985), which act as buffers against seasonal fluctuation in food availability. In theory, access to markets should provide opportunities for a more predictable and stable source of food capable of withstanding seasonal fluctuations and nutritional vulnerability traditionally experienced by forager-horticulturalists. In practice, however, the modes by which individuals and households become integrated into the market system are diverse. Differences in socioeconomic status and access to nonlocal foods at the household-level

have been seen as the principal factor mediating how seasonality is weathered (Leonard 1989).

Expanded opportunities to earn income through the market can potentially shore up seasonal dietary shortfalls if cash income is spent on food. Any beneficial effect of greater income from market activities may depend on the "regularity, size, and distribution of this income" (Dennett and Connell 1988:278). Income from sale of agricultural products and market activities is often seasonal and thereby a constraint to year-round purchasing of food resources. In Chapter 4, we saw that adult income from market activities is not stable throughout the year, but rather varies by seasonal demand for goods and labor. Drops in seasonal demand for crafts, agricultural goods, and labor can put households with no access to home production at risk (Messer 1989). Seasonality in income may render cash income inadequate to replace the home-produced diet with purchased foods (Dewey 1985). With increasing participation in the sale of agricultural products for cash income, it is possible that subsistence stores may be compromised for sale and thereby risk depletion of food stores intended for household subsistence security until the next harvest (Timmer et al. 1983).

Acculturation and changes in values and preferences for foods

Research has demonstrated that the process of acculturation into a dominant society leads to the decline in indigenous systems of knowledge and beliefs (Aunger 1996; Kuhnlein and Receveur 1996; Reyes-García 2001; Ventura Santos and Coimbra 1996). Novel cultural beliefs are introduced through contact accompanied by the recognition of one's status in relation to the dominant group, often as inferior and marginal (Henrich 1997). Awareness of food preferences and values of the dominant culture are enhanced through contact, exchanges, and interactions. The adoption of new

values and food preferences can pull members of the acculturating group into the market economy as consumers of market-valued items and away from traditional foods considered primitive by members of the dominant culture (Eder 1988). This can be problematic if high prestige foods are of lower nutritional value than traditionally consumed items. At the same time, better education about what foods to buy in the market and their nutritional value can also counter negative effects implied above (Kuhnlein and Receveur 1996).

In the Peruvian Amazon, Berlin (1985) noted that dietary practices are modified via acculturation or competition for resources with other populations. Prestige and status associated with different foods may counter any benefit of expanded education about food choices. Shifts in food taboos or avoidances can be affected by acculturation, essentially, redefining what constitutes food resources (Berlin 1985; Aunger 1996). These changes may be evident in younger generations (Receveur et al. 1997) that turn away from traditional knowledge, use, and preparation of foods.

Hypotheses

I have discussed several important features of the Amazonian diet that are subject to modification with greater acculturation and integration into the market economy. Source, diversity, and seasonality of food resources are all subject to change as households become more articulated with the market economy. In this chapter, I test the following three hypotheses about the relationship between integration to the market economy, acculturation, and diet using data from two Tsimane' communities.

> *Hypothesis #3* More acculturated and market-integrated households will have higher proportions of market foods in their diet and rely less on food resources from the farm or forest.

The effect of greater acculturation and participation in the market economy on household diet should be apparent through a greater dependence on market foods than on foods from the farm or forest.

> *Hypothesis #4* More market-integrated households will have greater diversity in their diet as measured by the number of different foods consumed.

Hypothesis #4 examines whether or not the Tsimane' are able to access a greater diversity of foods through their involvement in the market system.

> *Hypothesis #5* More acculturated and market-integrated households will have greater access to market foods during lean periods as a means of shoring up seasonal fluctuations in availability.

The Tsimane' experience a lean period during the preharvest/wet season (late November - early February) when local food resources are less available. If the market functions to expand availability and accessibility of food resources during the seasonal lean period, it should be evident through greater reliance on market foods compared with the less integrated households.

Methodological Limitations and Modifications

The 24-hour recall method used for collecting data on dietary intake and composition has limitations in accuracy and reproducibility compared to observational methods (Dwyer 1991) that merit attention before proceeding with the presentation of results. Originally, our research team designed the recall surveys to capture individual-level dietary consumption within each household. However, we encountered unexpected challenges to applying this method at the individual-level in the more remote community. Food habits that favor group (instead of individual) consumption for cultural or economic reasons (Cassidy 1994) can make this method difficult to execute. The Tsimane' custom of eating from a common pot was still regularly practiced in Yaranda. Most households

in San Antonio had plates for individual portioning of foods. When people eat from a common pot, it is almost impossible to collect individual-level data (Cassidy 1994; DeWalt 1983; Quandt 1996).

Additionally, a high degree of food sharing in Yaranda via eating meals with extended families at different times during a single day was an obstacle to capturing daily consumption of members of a single household. Similar methodological problems have been acknowledged as obstacles to studying food consumption within the household (Timmer et al. 1983; Ulijaszek and Strickland 1993). Also from as young as five years of age, children wander about the community with other children during the day and it is difficult for mothers to have known what, where, and how much they ate during the day. Direct observation of food consumption is intrusive and costly. Given the group consumption and food sharing between extended families in other households in Yaranda, determining individual eating patterns could not be accomplished by dietary recall. In response to this methodological obstacle, I modified my research design to conduct the dietary analysis by recall at the household rather than individual-level.

Another limitation to the 24-hour recall method in general is the tendency to underestimate intake because respondents omit frequently consumed items. Comparisons of data from 24-hour recall and written food records demonstrate that estimations of intake are often biased downward (Dufour et al. 1999). During the weigh day observations in households, our team observed first-hand the eating patterns and habit of children and adults. Children and women often graze on seasonal fruits throughout the day, eating them away from the household during errands or visits to other families. By informal observation, citrus fruits and papaya are regular parts of the individual diet, yet

they are not as well-recorded in our data. The absence of data on individual reports of each household member's "snacking" suggests that there is a degree of underreporting. However, it is difficult to assess the extent of underreporting of foods in our diet data.

Caloric analysis of household dietary intake is not included here because recall omissions reduce the available sample size of households with complete information about quantities of foods consumed. While there are limitations to the recall method, nevertheless the data generated using this method provided an estimate of typical available foods in different seasons. Having mentioned these limitations, I move on to present the results of descriptive and multivariate analysis possible at the household-level and discuss the significance of what our data contributes to the debate on markets and traditional diets.

Analysis of Tsimane' Household Diet

Description of General Food Consumption

Women are primarily responsible for food preparation in the household. In the absence of any teenage or adult women in the household males prepare food or eat with other relatives at mealtime. Cooking is done directly over exposed logs and fires located in the central part of the residential patio. Many houses have kitchen structures away from the sleeping structure. Metal pots are balanced on the logs and range from smaller pots for preparing herbal teas to large containers for boiling manioc or maize for *chicha.* During cooler months, families often move the logs inside to conserve heat and warm the house. During rainstorms, some households shelter the logs while others just look for dry wood or struggle to light damp logs after the storm's passing.

There was a general pattern of eating directly from a common cooking pot in Yaranda while in San Antonio most households divided food into plates or hollowed out

gourds of varying sizes. Additionally, the diet data reveal greater food sharing in Yaranda as evidenced by greater participation of nonhousehold members in the meals recalled as well as meals away from the home. This is possibly a function of the tighter network of extended families in Yaranda spatial layout of the community compared with San Antonio where meals are more often shared only within the nuclear family. Sharing of fishing and hunting returns might be a strategy to mediate seasonal availability of resources and short preservation times. Researchers have found that purchased foods are shared less and that reciprocal kin networks break down as household rely more on the market for food resources (Murphy and Steward 1968[1956]).

Despite the introduction of purchased foods and new crops over the last 500 years, the bulk of items in the Tsimane' diet is made up of plantains and fish processed traditionally into a variety of dishes. Table 7-1 lists the most common food items recalled from the daily household diet in order of prevalence.[18] Among meat items, the most common types of fish, game, purchased meats, and farm animals are listed.

Food crops

Plantains, consumed both in ripe and unripe states, are the most important staple to the household diet. Plantains are available year-round and are easily roasted for quick consumption. They are also the base of a stew (jo'ña) made from boiling shavings of unripe plantains in a cooking pot with pieces of fish or meat. After plantains, rice is the next most common food crop in the household diet. Unlike plantains or manioc, rice availability is determined by seasonal harvest cycles and exhibits periods of scarcity in the preharvest months. Manioc is eaten boiled, roasted, shaved into stew, grated and

[18] Foods are counted by presence in the daily diet, not by the number of times eaten during the day.

preserved as *chive,* or fermented into *chicha.* Maize was not as important in the diet on the cob or in grain form, but is consumed often as *chicha.*

Table 7-1. Most common foods in daily diet of Tsimane' households

Food Item	Scientific Name	Source
Plantains (all varieties)	*Musa sp.*	Farm
Fish (all species)		Forest
Sabalo	*Prochiludus nigricans*	
Venton	*Hoplias malabaricus*	
Pacusillo	*Schizodon fasiatum*	
Paleta	*Surubim lima*	
Salt		Market
Rice	*Oryza sativa*	Farm
Game meat		Forest
White-lipped peccary	*Tayassu pecari*	
Red brocket deer	*Mazama americana*	
Capuchin monkey	*Cebus apella*	
Collard peccary	*Tayassu tajacu*	
Market meat		Market
Beef		
Chicha (Manioc/Maize/Plantain)		Farm
Onion	*Allium cepa*	Market
Animal lard		Market
Sugar		Market
Vegetable oil		Market
Manioc	*Manihot esculenta*	Farm
White flour/bread		Market
Pasta noodles		Market
Farm animals		Farm
Chicken		

Forest foods

Wild foods were not recorded at high frequency in the dietary recalls. This is most likely due to patterns of eating wild foods such as fruits away from the home at the time they are encountered. Reyes-García (2001) reported that wild edible plants were the second most frequent type of plant brought into the household after firewood. Wild edible plants were eaten more often in Yaranda than San Antonio.

Meats

Fish are a mainstay of the Tsimane' diet and the most important type of meat despite seasonal fluctuations in availability. Fish resources are exploited more intensively during the dry season (August-October) when falling water levels concentrate fish in lagoons and rivers at greater densities. Most Amazonian populations depend on 10-30 species of fish (Gragson 1992). Thirty-seven different fish appeared in the dietary recalls. (cf. Pérez 2001 for detailed study on fishing activity in Yaranda and San Antonio). The Tsimane' employ several techniques for preserving fish including salting and sun-drying or smoking fish wrapped in plantain leaves, the former which results in longer preservation. Some authors argue that the importance of fish in the Amazonian diet is often overlooked in favor of terrestrial resources (Beckerman 1993; Gragson 1992) even though in many environments fish are more abundant over time and more productive than hunted game. Fish accounted for 80% of meat items reported in dietary recalls in Yaranda and only 25% in San Antonio (Table 7-2). Residents of Yaranda practice communal fishing techniques such as fish poisoning to a much greater extent than residents downriver in San Antonio. *Barbasco* fish poisoning typically results in high returns to participating households.

Hunted game is important to the Tsimane' diet as well. Households reported having eaten peccaries, deer, and several species of monkey most often in the dietary recall. Beef and beef products are the most common purchased meats consumed and chickens are the principle livestock. Beef and other purchased meats account for over a third of the total types of meats recorded dietary recalls in San Antonio.

Meat consumption is nutritionally and culturally important to the Tsimane'. The analysis of meat foods in the diet shows interesting differences in resource acquisition.

Table 7-2 displays the breakdown of sources of meat by community. The Tsimane' still depend on the forest for 75% of the different meat foods in the diet. Sources of meat items recorded in the recalls are as follows: fish (53%),[19] game meat (22%), market (19%), and farm meat (6%). Purchased meat was less common in Yaranda compared with San Antonio. The Tsimane' are not heavily involved in animal husbandry and the farm is not an important source of meat or other proteins (other than rice) in the diet. In general, the descriptive analysis of the diet data does not support the prediction that the Tsimane' people are shifting their consumption from hunted game and fish to domesticated animals. Despite increasing articulation with the San Borja economy, meat sources from the forest (fish and game) are still the most important to the household diet. However, the difference in importance of beef and other purchased meats at the community-level is considerable. Households in Yaranda do not rely on the market as a source of meat compared with households in San Antonio.

Table 7-2. Type and source of meats in household diet by community

Meat Type	Source	San Antonio	Yaranda	Total
Fish	Forest	25%	80%	53%
Game	Forest	30%	14%	22%
Beef or other purchased	Market	36%	3%	19%
Chickens and pigs	Farm	9%	3%	6%
Total Meat	All	100%	100%	100%

Purchased foods (nonmeat)

The most common nonmeat foods in the household diet originating in the market are salt, animal lard, sugar, and vegetable oil. These items are acquired through purchase in town or barter with river traders and are used in the processing of other foods. Salt is

[19] The tendency to have multiple fish species in a single catch may account in part for the high percentage of fish in the diet.

relatively inexpensive (1 kg. = 0.50 Bs.[20]) and economically accessible, while sugar (1 kg. = 2.5-4 Bs.) and oil (1 liter ~ 5 Bs.) on average are more expensive items. Without salt, there would be little preservation of game and fish resources. Our team observed that Tsimane' in San Antonio incorporated sugar into their diets and more often considered in a necessity compared to its value in Yaranda.

The Tsimane' diet can be characterized as high in carbohydrate. The main sources of protein are fish and game. Animal lard and vegetable oil contribute to fat intake. This pattern conforms to other findings of Amazonian diets and as a group. Overall, I did not find evidence of a shift away from traditional sources of meat to market substitutes. However, community differences exist with a higher consumption of meats from the market in San Antonio than in Yaranda. The forest is still the most important source of dietary protein for the household diet. Farm production accounts for the largest source of carbohydrate.

Comparison of nutritional content of traditional foods versus market substitutes

Dietary recall did not yield accurate or specific enough data to determine nutritional content of foods consumed by individuals or households to an acceptable level of certainty. However, a general examination of common foods consumed provides insight into the nutritional content of the household diet. Table 7-3 provides the nutritional content of some of the most common traditional and market foods by 100g edible portions. Plantains and manioc are good sources of carbohydrate but only minimally contribute to intake of protein or iron. Rice is a better source of dietary protein, iron, and energy in the diet than plantains or manioc. The market staples of pasta noodles and

[20] Average exchange rate during 5 quarters of study was 6 Bs. □ U.S. $1.

white flour are comparable with rice in energy (kcal) contribution and may function as adequate substitutes. White flour is a poor source of iron while noodles provide almost similar quantities of iron as rice per weight. This suggests that bread and fried dough are not nutritional equivalent substitutes for farm starches. The Tsimane' "farm" diet consists of starches from cereals and tubers and is generally low in protein with the exception of rice. A household diet high in market foods would likely include sugar, animal lard or vegetable oil, white flour fired into pancakes or bread, pasta noodles, and beef. This more "market" diet includes more fats, refined sugar, and processed carbohydrates. The Tsimane' do not purchase many fruits or vegetables from the market except onions. These foods still come from the farm.

Table 7-3. Nutritional contribution of common foods in Tsimane' diet, conversions for 100g edible portions

Food	State	Water (%)	Energy (kcal)	Protein (g)	Fat (g)	Carb. (g)	Iron (mg)
Plantains[a]	ripe	65.6	122	1.0	0.3	32.3	0.8
Plantains[a]	unripe	62.6	132	1.2	0.1	35.3	0.8
Rice[b]	dry	13.1	358	7.1	0.4	78.7	7.8
Manioc[b]	raw	62.2	148	1.1	0.2	35.5	1.2
Maize[b]	raw	71.0	103	2.6	1.0	24.6	1.0
Noodles[b]	dry	13.5	355	11.2	0.9	73.8	7.4
White Flour[a]	unfortified	12.0	364	10.5	1.0	76.1	0.8
Lard (cow)[b]			840	1.7	92.4	0.0	0.3
Vegetable oil[b]	liquid	0.07	881	0.8	99.3	0.0	0.4
Peccary[c]	raw		162				
Sabalo Fish[b]	cooked	66.9	169	21.3	7.0	3.8	4.3
Beef[b]	raw	70.1	135	20.2	2.9	5.8	3.8
Beef[b]	charqui	28.6	256	47.6	3.4	5.7	15.2

[a] 1996 Tabla de Composición de Alimentos de Centroamérica, Primera Sección; [b] 1984 Tabla de Composición de Alimentos Bolivianos; [c] Hill et al. 1984

Among meats, fish and beef are comparable in energy contribution by weight, but fish contribute significantly more grams of desirable fats to the diet.[21] Nutritionally, beef

[21] Nutritional information broken down by micronutrients of game meat is hard to obtain.

is probably a suitable substitute for this population, however, they most often consume the head, tripe, tongue, and stomach, parts that are not as rich in protein. Economic access, however, may result in lower quantities of meat consumed compared to the amount of fish or game a household can acquire. Canned sardines are another popular market food dense in nutrients and fats but expensive by volume compared to beef or forest meats.

Value of market foods

While living in the two communities we observed differences in values placed on market foods. In San Antonio, the importance of having pasta noodles and beef during community-wide meals to celebrate holidays or during an important meeting was unheard of in Yaranda. Cash quotas are gathered and a resident is sent to town to purchase foods for big events in San Antonio, whereas hunted game or a slaughtered pig suffice without question in the more remote Yaranda. The tastes for market items such as pasta, white flour/bread, sugar, and beef were strong in San Antonio illustrated through mothers' claims that they "needed" sugar for their infants and young children.

Over the course of 18-months of residence in the two communities, our team compared the observations and impressions of attitudes toward market foods, and goods in general. We concluded that market goods have a higher social value and demand in San Antonio. I attribute this trend, in large part community-level, to greater exposure, proximity, and influence which results in increased demand and desire for market goods. In Yaranda, the traditional lifestyle is not constantly challenged or denigrated by the dominant regional culture. Tsimane' living in close proximity to town are more regularly exposed to devaluing and comparison of their native culture to the nonnative culture. Males who travel to town for educational, political, and economic purposes are the main

couriers of novel ideas and products back the community. Exposure may outweigh education as the aspect of acculturation that most influences food preferences. As discussed in the literature review, the Tsimane' are being pulled into the consumerism of market goods including novel food items.

Hypothesis Testing

The discussion now shifts to the testing of the three hypotheses about market integration, acculturation, and diet among the Tsimane'. The indices used to test the hypotheses about how market integration and acculturation affect source, diversity, and seasonality of the Tsimane' diet are listed in Table 7-4 along with definitions.

Table 7-4. Indices of dietary analysis

Variable	Definition
Source of foods	
Forest	% of distinct foods items from the forest
Farm	% of distinct foods items from the farm
Market	% of distinct foods items from the market
Diversity Scores	
Dietary Diversity (DDS)	Total number of different foods eaten in 24-hours
Market Diversity (MDS)	Total number of purchased foods eaten in 24-hours

Source of foods

> *Hypothesis #3* More acculturated and market-integrated households will have higher proportions of market foods in their diet and rely less on food resources from the farm or forest.

The Tsimane' diet is comprised of foods from three sources: the forest, household farm plots and animals, and the market system. The percentage of market food compared to locally harvested resources is one indicator that differentiates households' reliance on the market (Receveur et al. 1997). To analyze the origin of the Tsimane' household diet, I calculated the percentage of household diet by source. I totaled the number of items from each source and then divided by the total number of distinct items reported in the

daily diet. Table 7-5 displays summary analysis of the average proportion of food items in the daily household diet by source over all five quarters. The greatest proportion of items (47%) came from farm production. In the total sample, the foods from the market represent a slightly larger proportion (29%) of items in the household diet than forest foods (23%). These aggregate values suggest that the market is equally if not more important as a source of foods than the forest.

Table 7-5. Source of Tsimane' diet, average percentage of items in daily household diet by community

				Between Community	
Source	San Antonio	Yaranda	Total	t-stat	P
Forest	15.6%	32.4%	23%	8.0	0.001
Farm	44.3%	50.8%	47%	2.7	0.01
Market	40.1%	16.8%	29%	-9.4	0.001
All sources	100%	100%	100%		

When I group the data by community, a different pattern emerges. Table 7-5 shows significant community differences in source of foods. Analysis of the source of food items in the daily household diet reveals significant differences ($P<0.01$) between the two communities for all sources. The daily diet of households in Yaranda is on average more dependent on foods from the farm (50.8%) and forest (32.4%) than the market. In San Antonio, the farm (44.3%) and market (40.1%) account for the bulk of food items in the daily diet with forest foods contributing only 15.6 %. It is clear that distance from the market town explains part of access and inclusion of market foods in the household diet. Food acquisition techniques also influence the source of the diet. The *barbasco* fishing techniques in Yaranda normally result in multiple species in a single day's effort. Multiple species of fish eaten during a single day were counted separately and therefore drive the forest item count upward.

To discern whether differences in source of foods are being driven more by community factors than household factors, Table 7-6 presents the same analysis disaggregated by average income levels for households during the study. I ran an analysis of variance (ANOVA) on income grouping for each source of food items. There is a clear pattern of unequal means across all three categories ($P<0.02$ for all three). I also ran t-tests to compare the values at the extreme ends, between households in the upper and lower third on average monthly income. The most marked difference is the percentage of market foods between households in the upper and lower average monthly income group ($t = 5.0$; $P<0.001$). Poorer households rely the least on the market for food. The richest third of the households rely the most on the market, even though the farm is still the most important source of foods. The significant difference by household groups suggests that income is associated with the incorporation of market foods into the household diet. It is not merely a community or distance variable driving the differences.

Table 7-6. Average percent of items in daily household diet by income groups by thirds

				ANOVA		Between upper and lower third	
Source	Lower	Middle	Upper	F-stat	P>F	t-stat	P
Forest	26%	25%	19%	3.86	0.02	-2.56	0.01
Farm	53%	46%	43%	6.26	0.00	-3.39	0.00
Market	21%	28%	38%	12.61	0.00	5.01	0.00

The results suggest that the first part of my hypothesis is correct. More market-integrated households, as determined by their average monthly income from all measures during the study, have the highest proportion of market foods in their diet (38%) than the other two thirds. The middle and lower income households look more alike in the source of their foods. Nevertheless, farm foods are still the most important by percent of items

in the household diet for all three income groups. Households in the upper third reported the lowest percentage of foods from the forest.

Multivariate model

I further tested Hypothesis #3 using multivariate regression analysis. Using the household-level measurements of integration into the market and acculturation, I tested whether households more acculturated and integrated into the market have higher proportions of market foods in their diet, relying less on food resources from the farm and forest. The model is as follows:

Model 1

Percent Market = household income + household wealth + household credit + average age + max school grade + community + hhold size + mean rainfall.

Model 2

Percent Market = household MI Factor + average age + max school grade + community + hhold size + mean rainfall

Quarterly household cash income proxies the involvement in the market economy and time away from subsistence activities such as farming or hunting. Total quarterly household wealth and credit are included as other measures of market integration. For household-level measures of acculturation, I took the maximum school grade of the female and male household head. I calculated an average age between the two household heads to control for possible generational differences in use of market foods. I controlled for the effects of community of residence, household size, and season. The sample for analysis is 216 household days of diet recall over the five quarters.

Table 7-7 summarizes the results of the regression analysis. I ran one model using household variables and then a second model substituting the household factor of market integration. Household wealth is significantly correlated with the percent of food items

from the market in Model 1(P<0.01). A one percent increase in monthly household wealth correlates with a five percent increase in the proportion of daily foods from the market. Results from Model 2 also show a positive and significant relationship between the factor of household market integration (P<0.05) and the dependent variable.

There is evidence in both models that the highest school grade of one of the household heads is associated with higher market reliance. Each additional year of schooling to the most educated household head correlates with a two percent increase in market foods compared to total food items in the household diet. Finally, a significant community effect appears, reinforcing my previous findings that community-level factors are largely correlated with use of market foods (P<0.01). Residence in San Antonio is associated with 26% more market foods.

Table 7-7. Regression results for effect of market integration, acculturation, and control variables on percent of total foods from the market (MDS/DDS)

Independent Variable	Model 1‡	Model 2‡
Market Integration		
Log Household Income	0.00	
Log Household Wealth	0.05***	
Log Household Credit	-0.00	
Household Income Wealth Factor		0.03**
Acculturation		
Average Age Heads	0.00	0.00
Maximum School Grade	0.02**	0.02*
Controls		
Community	0.26***	0.26***
Household Size	-0.01	-0.00
Mean Rainfall	0.01	0.00
Constant	-0.27	0.10

Significance levels: *P<0.10; **P<0.05; ***P<0.01
Robust models noted with ‡ symbol.

Dietary diversity

Hypothesis #4 The more market-integrated households will have greater diversity in their diet as measured by the number of different foods consumed.

Dietary diversity is defined as the number of distinct food items in the diet. In this case, the unit of analysis is a single 24-hour period per household. A Dietary Diversity Score (DDS) can be used to compare the variety of foods in the diet (Leonard et al. 1994). Here, I test my hypothesis that more integrated and acculturated households have greater diversity in their diet as measured by the number of different foods consumed. Table 7-8 presents summary analysis of DDS by income groupings. Analysis of variance indicates that the average DDS for each third are not equal ($F = 11.67$; $P<0.001$). The biggest difference exists between households in the lower and upper thirds on the average monthly income distribution with higher diversity in the upper income household group. The largest variation is found among households in the upper third (SD = 3.2).

Table 7-8. Dietary Diversity Score (DDS) by income thirds

Household Grouping	Mean	SD	F-stat	Prob >F
Lower Third	6.1	2.2		
Middle Third	6.9	2.7		
Upper Third	8.3	3.2		
Total Sample	7.1	2.9	11.67	0.00

Overall, variation in DDS among Tsimane' households is small. There is not evidence that households in the upper income group are including many more foods in their diet than lower income households. Differences of one or two food items may not be very noteworthy. Even so, this basic analysis suggests that more integrated household have slightly more diverse diets on average.

Seasonal reliance on the market

> *Hypothesis #5* More acculturated and market-integrated households will have greater access to market foods during lean periods as a means of shoring up seasonal fluctuations in availability.

Figure 7-1 shows the average proportion of foods originating in the market included in the household diets for each quarter of observation. In San Antonio, the

highest percent of market foods was found in the wet/preharvest season (Quarter 2) and the lowest during the dry/cool season (Quarter 4) when hunting is at its peak and the rice stores are high. This suggests that the market may be a seasonal alternative to low availability of farm or forest resources for the residents of San Antonio. There was less seasonal variation in use of market foods in Yaranda. Residents in Yaranda may be adopting a more conservative strategy toward dependence on market items in their dietary portfolio due to their distance and greater isolation from the market town. They may be better-off investing in home production and wild resource acquisition because market access is more variable and less predictable.

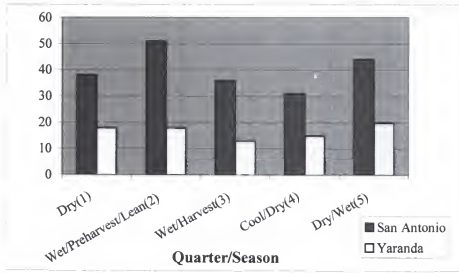

Figure 7-1. Percent of diet from market foods by community for each quarter of study

Figure 7-2 examines seasonal use of market foods by household income groupings. A clear pattern of greater reliance on market foods during the wet/preharvest/lean season by households in the upper third of monthly income is evident. Households in the middle third of average monthly income have less variability in use of market foods in the diet. A dip in use of market foods as a percent of total food items occurs during the wet/harvest and cool/dry season among households in the lower third. Households in the

lower third increase their use of market foods during the lean period (Quarter 2), but do not reach the levels of households in the upper third. A drop back down to a lower percent occurs with the beginning of the rice harvest. The figure suggests that when the lean period sets in, households with the highest average monthly income increase their reliance on market foods more than the other two income groups. It is reasonable to assume that this implies greater access to market foods during the annual lean period.

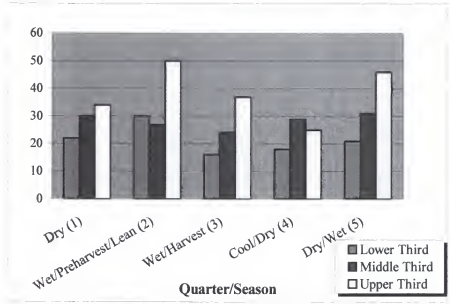

Figure 7-2. Percent of foods from market by income groupings in thirds

Discussion

Chicchón (1995:241) asserted that "the production of cash crops permits the Tsimane' to participate in the market economy and at the same time maintain a reliable source of food." Dietary data from the two study communities corroborates this statement. My analysis indicates that greater integration into the market economy is associated with a higher percent of foods from the market in the household diet, although market foods still do not surpass farm foods regardless of level of market integration. In

addition, households that are more integrated show signs of turning away from forest foods to incorporate more market foods in the daily diet.

Differences in source of meat resources, one of the most important and socially valued classes of food items, appear between communities. Households in the community in closest proximity to the market town rely more on purchased and farm meats than households in the more distant community. These differences suggest dietary differences associated with proximity, contact, and access to resources of the wider society.

Nutritionally, substituting purchased meats for farm and wild meats does not represent a major change in dietary intake. My analysis is limited in that I am unable to compare quantities of foods eaten between all households in the sample to assess whether the amount of foods consumed is changing. Many of the market foods we casually observed during our residence in the communities can be classified as novelty foods such as sugar, cookies, processed sweets, and alcohol. However, these items did not figure prominently into the diet recall. These items may have escaped the 24-hour recall as they are often consumed away from the household. Whether or not cash income is used to purchase better quality food resources, or even more of the same items is unclear in our data. But we do see specific items such as flour and bread that are status substitutes for rice consumption as market access increases.

During our study (1999-2000), farm resources were still the most important source of foods in the Tsimane' household diet. Signs of shifts toward increased consumption of market foods were present. There may be no notable changes to traditional diet until production patterns are affected by market participation (Guyer 1989:143). Sale or barter

of agricultural goods were demonstrated to be the most important sources of market income for the Tsimane'. These same goods are part of the subsistence production for the household. During my research it was not uncommon for Tsimane' households in San Antonio to sell off nearly all of their rice early in the season and either have to purchase more as supplies run out or turn to alternate foods. The motivation was often to acquire cash and therefore access goods and services traded in the market town. Casual observation concludes that this demand is increasing with greater exposure to the market system and culture. This is a strategy only viable to those in proximity to wage income opportunities and who can replace diminished food stores. In contract, Yaranda residents would not sell their rice to the research team living there as they have less access to replacement than in San Antonio. Less market-integrated households presumably have fewer alternatives to dietary shortfalls in the lean season. If they commercialize all their subsistence production rather than consume it throughout the year households may face reduced access to resources during the lean/preharvest period.

Finally, time allocation data would be useful in future research. Households in San Antonio may devote more time to agricultural production because they intend a greater amount of products for the market. This would coincide with lower reliance on forest resources and greater dependence on farm and market foods. This strategy would result in less time devoted to hunting, fishing, and collecting wild resources. Comparative analysis of time allocated to different productive activities would address these uncertainties.

CHAPTER 8
NUTRITIONAL STATUS

Introduction

The objective of this chapter is to analyze the effects of acculturation and integration into the market economy on the nutritional status of Tsimane' children and adults. Data on the nutritional status of Amerindian populations are not widely available. Much of the research on the nutritional health of Amazonian populations is descriptive in nature, assessing present nutritional status of a particular group with comparisons to international reference values. Limited research has been conducted to examine the possible correlations between socioeconomic integration and nutritional status within a single ethnic group in the Amazon (Flowers 1983; Holmes 1993; Ventura Santos and Coimbra Jr. 1996). Most studies point to high levels of linear growth stunting in both children and adults, yet low incidence of wasting compared to international reference standards (Dangour 2003; Dufour 1992; Dufour 1994; Hodge and Dufour 1991; Holmes 1985; Orr et al. 2001; Stinson 1989; Stinson 1996). These findings are often interpreted to indicate adequate present nutritional status, yet long-term nutritional stress, which almost certainly interplays with incidence of infectious disease (WHO 1995). Analyses of these patterns in Amerindian populations suggest that dietary and disease states are associated with conditions of the social, economic, and physical environments.

The possible nutritional consequences of socioeconomic change among Amazonian populations are less understood (Dangour 2003; Ventura Santos and Coimbra Jr. 1996). Higher levels of integration into the market economy and acculturation into the wider

society can potentially affect individual and household nutritional status. Access to income, material wealth, and education may contribute to better nutritional status by way of improved dietary intake, access to medical care, and knowledge about foods and health. At the same time, transition away from traditional means of subsistence procurement may render households and individuals more vulnerable to uncertainties in meeting energy requirements, ultimately compromising their nutritional status. In this Chapter, I analyze the nutritional status of Tsimane' adults and children varying in measures of integration to the market economy and acculturation to address these unresolved issues.

I begin with an introduction to the analysis of nutritional status using anthropometric assessment. Next, I provide a synopsis of important findings from research on acculturation, integration, seasonality, and nutritional status, with specific reference to findings from studies on indigenous populations in the Amazon region. I introduce two hypotheses about the effects of integration into the market and acculturation on child and adult nutritional status. Before testing the two hypotheses using data from Tsimane' residents in two study communities, I discuss summary analyses of measures of Tsimane' nutritional status, dividing the data into child and adult samples. After a discussion of nutritional status, I present the model and results from multivariate analysis using four different outcome measures. Finally, I discuss the findings from my analysis.

Measuring Nutritional Status through Anthropometry

Unlike self-reported illness episodes (cf. Chapter 6), anthropometric assessment of nutritional status is an objective measure of health that provides information about long and short-term growth and development. Body composition is a representation of many

causal factors including diet, heredity, disease stress, genetic endowment, energy demands, and the social and physical environments (Murray and Chen 1992; Ulijaszek and Strickland 1993). Anthropometric methods are low-cost, easily taught, and involve less user interpretation compared to survey techniques. Several of the most common measurements include height, weight, and skinfold thickness. Additional indicators of body composition calculated using these measurements include Body Mass Index (BMI), upper Arm Muscle Area (AMA), and age-based indices (weight-for-age, height-for-age, and weight-for-height).

Reference Standards and Interpretations

In order to compare results across populations and to influence nutritional policy, researchers need to move beyond descriptive analysis of nutritional data (Keller 1991). International reference data are widely used in the interpretation and comparison of anthropometric measures of nutritional status across populations. International reference data are based on the inherent assumption that all individuals have the same genetic growth potential (Keller 1991). These standards are derived from a population where the absence of environmental inhibitions to growth is assumed. Similar patterns of growth among the affluent populations in poor countries regardless of ethnic make-up are attributed to good access to public health, diet, and socioeconomic status (Dufour 1994). As a result, affluent populations of one country tend to look more like those of other countries than of their same ethnic poor within their country. The appropriateness of comparing data from the assessment of nutritional status in traditional economies to references based on U.S. standards has been questioned (Strickland 1990). On the one hand, many scholars support the practice of using a single reference set for all populations as it facilitate comparisons, while others argue that it is more appropriate to

use population-specific references for comparison (Holmes 1993). National or population-specific references values may be ideal, but are difficult and costly to establish.

Summary of Research on Nutritional Status in the Amazon

Data on the nutritional status of Amazonian populations measured through anthropometric assessment is not as plentiful as for other segments of developing nations in South America. Existing studies have found similar patterns of growth and nutritional status among lowland Amerindians. Compared to international reference data, Amazonian populations consistently fall short on indices of stature (height-for-age and weight-for-height) and demonstrate significant percentages of stunting (Holmes 1985; Stinson 1990). Malnutrition is often manifested through growth retardation and evidence of slow or stunted growth can signal greater risk of morbidity and mortality (Haas 1990). However, populations are generally not found to be underweight for individuals of corresponding heights and ages. In a study of two Kayapo populations in Brazil, researchers concluded that nutritional status measured through anthropometric, clinical signs, and laboratory tests was generally good (Black et al. 1977). Johnson and Behrens (1982) describe the Machiguenga of the Peruvian Amazon to be reasonably healthy, apart from the similar patterns of shortness. Dangour (2003) found significant differences between Patamona and Wapishana populations in Guyana to be related to differences in childhood growth. In a study of the Shipibo of eastern Peru, Hodge and Dufour (1991) found low height-for-age, but adequate weight-for-height in children. Many scholars suggest that these findings are consistent with developing nation data for growth under conditions of mild-to-moderate undernutrition.

Adult stature reflects, in part, a long-term net effect of nutrient intake and sickness during childhood development (Arora 2001). Short adult stature is generally attributed to stunted growth during early childhood. Most of the detrimental growth faltering probably occurs before age three. Because children are still growing, their nutritional status is more sensitive to both short and long-term change in food availability and disease. Hodge and Dufour found linear growth retardation among Shipibo children to begin between three and six months of age and continue through the third year of life. Despite undergoing a period of rapid acculturation, the authors believe that this is not a new pattern as adults show short stature that would result from similar patterns. Poor child growth performance can lead to stunted adults. Insults to growth during childhood, especially before three years of age, can predispose individuals to lower adult measures even below typical population averages.

Competing explanations of linear growth retardation in Amazonian populations exist. One argument suggests that small body size and high levels of stunting are a reflection of adaptation to environmental stress whereby genetic factors select for smaller individuals requiring fewer food resources (Holmes 1993; Holmes 1995; Seckler 1982). Thus, individuals are "small but healthy." Smaller individuals have lower energy needs leading some to interpret this as an efficient adaptation to historical food stress and causing no alarm for addressing nutritional circumstances.

This position has been challenged suggesting that the environmental and socioeconomic factors that lead to smaller body size are unhealthy and therefore should not be considered adaptive (Martorell 1989). According to this argument linear growth retardation is interpreted as one physiological response to the stress of lower energy

intake, which results in shorter individuals relative to one' population and/or reference population. Waterlow (1990) argues that stunted growth is a consequence of childhood malnutrition not genetic selection and is a more a reflection of poverty than genetics (Martorell 1989). This unresolved issue has implications for the interpretation of nutritional assessment and direction of national health policies. Analogous results pointing to pervasive stunting question whether even under optimal conditions, these populations would still fall short in height indices based on the argument of genetic selection.

Socioeconomic Factors Correlates of Nutritional Status

Beyond descriptive and comparative analysis of the nutritional status of Amazonians, few studies have attempted to examine nutritional status relative to socioeconomic factors, acculturation, and cultural transitions. Studies of the nutritional status of tropical forest peoples contribute to our understanding of how the process of acculturation and economic integration of previously isolated or marginalized populations affects their physical welfare. I summarize some of the research findings in this field related to economic and nutritional indicators of Amerindian populations.

Through research in the Venezuelan Amazon, Holmes challenged the assumption that traditional villages have better health, measured by nutritional status, than more "civilized" populations (1985). The assumption that traditional populations have better health suggests that they are successfully adapted, both biologically and culturally, to their environments (Holmes 1985; Wirsing 1985). Moreover, indigenous groups may experience poorer health with increased contact with more technologically developed populations as they are not adapted to the new context and often occupy low-status marginalized positions in the market system. In her study of four villages reflecting

different levels of acculturation, Holmes found no significant difference in nutritional status of the individuals sampled.

Analyses of longitudinal data examine nutritional status in the context of changing subsistence patterns. Flowers (1983) conducted a comparative study of the Xavante of Central Brazil, a once primarily nomadic hunter-gatherer population who at the time of study had only recently incorporated agriculture into their mode of subsistence and become settled. She examined whether increased reliance on agriculture, a proxy for food security, correlated with better nutritional status. Flowers found no change in child nutritional status from three surveys over 15 years providing little evidence that transition from foraging to greater dependence on agriculture would produce a more reliable food supply.

Comparative research between different ethnic groups or populations has also been undertaken to explore variation in nutritional status. Orr and colleagues (2001) compared Tukanoans children of Colombia with Achuar of Ecuador who inhabit ecologically distinct regions with different resource availability. They found significant differences between groups only for height-for-age indices. An assumed higher quality diet of the Achuar based on both higher quantity and frequency of consumption of animal protein is suggested to explain some of the differences in long-term linear growth in children. However, they do not rule out other reasons such as error in estimating ages and secular trends as data come from different time periods.

Stinson (1996) studied two Ecuadorian populations living in similar environments but of different genetic origin. She found a positive correlation between socioeconomic index and anthropometric measures in a comparison of Afro-Ecuadorians and Chachi

children. She also noted differences in height between groups that are likely attributed to genetic differences calling into question the use of single set of reference values.

Emerging social and economic differentiation among the Suruí brought about by external forces of Brazilian development, colonization, and highway expansion have been linked to changes in adult body composition (Santos and Coimbra Jr.1996). Santos and Coimbra Jr. (1996) concluded that recent cultural and socioeconomic changes have affected adult weight and fat stores by way of dietary and lifestyle alterations. Participation in the market economy altered the division of labor and consumption needs of Suruí household. Adults in higher socioeconomic households showed an increase in fat and carbohydrate intake and reduction in activity levels.

Evidence that household wealth, measured through asset indices and values, affects nutritional status comes from several studies (Dangour 2003; Santos and Coimbra Jr. 1996). In Guyana, Dangour found significant differences in both female and male adult nutritional status. He found adult BMI to be sensitive to current wealth, measured in a similar way to our study in which the number of assets on a predetermined list are counted and values are calculated. He ruled out secular changes based on consistencies in other body measurements. The existing research suggest economic variables are either independent or positively influence nutritional status in the Amazon. A clear pattern does not emerge, possibly attributed to single cross-section research designs that cannot account for seasonal variation in economic participation and food availability.

Hypotheses on Market Integration and Nutritional Status

Child growth and nutritional status is widely used as an indicator of population welfare (Chávez et al. 2000; Dietz et al. 1989; Frisancho 1990; Martorell 1989). Children may be susceptible to acute change in household income and food availability.

Causes of childhood stunting are difficult to discern but the condition is often tied to dietary factors either qualitative (composition of diet) or quantitative (amount of food consumed). The high bulk diet (Dufour 1992) characteristic of the region, (discussed in Chapter 7), can limit the ability of children to consume adequate quantities of nutrients during important growth phases. Disease also is another factor behind thinness and slow physical growth (Dufour 1992; Dufour 1994; Frongillo et al. 1997). Many of these differences may be driven by access to income, source of food resources, and subsistence production. By comparing the nutritional status of children living in households with different levels of integration into the market, I explore possible links between economic circumstances and biology. I examine whether greater income and wealth mediate these effects and probe the relationship between the nutritional status of children living in more integrated households. At the same time, more acculturated parents may transfer beneficial health effects to their children as well. For example, measures of maternal education and literacy have been found to be positively related to child nutritional status in national-level comparisons (Frongillo et al. 1997). Maternal education and knowledge about food composition and preventative health likely work in favor of child health. Using data from Tsimane' children in Yaranda and San Antonio I test the following hypothesis:

> *Hypothesis #6* Children living in households more integrated into the market economy and with more acculturated parents, specifically mothers, will demonstrate better nutritional status than their less-integrated counterparts.

Tsimane' adults are past the phases of developmental growth. Analysis of adult data provides a different type of information about how individual differences in market integration might be related to nutritional status. Higher incomes and wealth may enable adults to access beneficial inputs, enjoy more leisure time, and suffer less disease. Adults

of higher socioeconomic status may engage in less physical activity, while at the same time increasing consumption of fats and carbohydrates. These differences mediated through economic resources should be obvious in a comparison of short-term measures of nutritional status. Hypothesis #7 examines the influence of individual-level acculturation and integration into the market on adult nutritional status.

> *Hypothesis* #7 More acculturated and market-integrated adults will demonstrate better nutritional status than less integrated adults.

It is difficult to assess whether there are any trends in Tsimane' nutritional status over time as historical anthropometric data do not exist. However, measuring the variation in degree of market integration and repeated measures of nutritional status on the same individuals goes beyond many of the cross-sectional studies. I also compare findings from research among the Tsimane' to other Amazonian populations. If their range of nutritional status is comparable then they might serve as an example of how variation in socioeconomic conditions affects nutritional status.

One important consideration in multivariate analysis is the threat of endogeneity between dependent and independent variables. In the case of health, poor health caused by poor nutrition may lead to decreased economic activity and income. Likewise, lower incomes may be the causal factor behind poor nutrition. To overcome this problem, our research design built in a lag-time between the collection of economic data and measurement of nutritional status (cf. Chapter 2 Methods). Nutritional change is slow and thus time delay is essential to properly estimate casual relationships (Behrman and Deolalikar 1988). Repeated measures of economic and nutritional indicators over time can account for some of this problem (Frongillo et al. 1997; Hodge and Dufour 1991; Waterlow 1986).

Analysis of the Tsimane' Nutritional Status

Definitions of the anthropometric measurements and indices of nutritional status analyzed in this chapter are listed in Table 8-1. For my analysis I standardized indicators of nutritional status using the National Center for Health Statistics (NCHS) percentiles as Z-scores. Z-scores represent the distance of an individual's measurement from the median value for the reference population measured in standard deviations.

Table 8-1. Definitions of anthropometric measures and indices of nutritional status

Variable	Definition
Weight-by-Height Z-score (WHZ)	Index of body composition reflecting short-term changes in weight, normalized to Z-Scores, test for wasting (kg)/(cm)
Height-for-Age Z-score (HAZ)	Index of body composition reflecting long-term patterns in linear growth, normalized to Z-Scores, test for long-term mild-moderate nutritional stress and stunting (cm)/(years)
Weight-for-Age Z-score (WAZ)	Index of body composition reflecting general size but not as specific, normalized to Z-Scores; (kg)/(years)
Body Mass Index (BMI)	Measure of body composition in adults Weight (kg)/[Height (m)]^2
Arm Muscle Area	Indirect measure of muscle mass that takes bone and subcutaneous fat into consideration, normalized to Z-scores (ZAMA). [Arm Circumference (cm) - (Triceps (cm) x Π)]^2 /4 Π
Sum of 2 Skinfolds Z-score (Z2Skin)	Sum of 2 skinfolds thickness normalized to Z-scores sensitive to short-term change in subcutaneous fat stores, a good measure of caloric/nutrient reserves. Standardized measure of body fatness Triceps(mm) + Subscapular(mm)
Chronic Energy Deficiency (CED)	Classification of energy deficiencies or excesses by BMI

Heights and weights for children were converted to standardized Z-scores using ANTHRO software (Sullivan and Gorstein 1990) available from the Centers for Disease

Control and Prevention. The routine involves incorporating the date of measurement with the date of birth of each individual to calculate sex and age-specific Z-scores. The reference values are available for girls shorter than 138 cm and boys below 146 cm in height. The age limit for these reference comparisons is 9.99 years for girls and 11.49 years for boys. Because of these limitations, I wrote a program in STATA to convert raw measurements into standardized scores based on National Health and Nutritional Exam Survey (NHANES) norms available in Frisancho (1990) for adults and children older then 9.99 years. Indices of arm muscle area (ZAMA) and summed triceps and subscapular skinfolds (Z2Skin) were converted using norms published by Frisancho (1990). I omit analysis of adolescents because physiological changes during the teenage years can confound comparative analysis.

Indices of body weight are sensitive to short-term changes in available nutrients. Wasting, defined as having a Z-score for weight-for-height (WHZ) two or more standard deviations below the median of international reference standards, can indicate periods of acute malnutrition or disease. Low weight-for-height (WHZ $\leq$ -2.0) might indicate a thin or wasted body that has experienced a reduction of soft tissue mass, generally attributed to an imbalance in energy requirements and supply (Keller 1991). Other possible causes of wasting include low food availability, chronic diarrhea, or febrile illness. Indices of weight-for-height in children are more specific than age-based indices and provide information about changes in soft tissue rather than body frame due to age (Keller 1991). Weight-for-age (WAZ) information is less useful because it conceals variation due to small body structure and composition. Low weight-for-age (WAZ $\leq$ -2.0) signals underweight in individuals.

Physiologically, linear growth stunting is defined as having a Z-score for height-for-age (HAZ $\leq$ -2.0) two or more standard deviations below the median of international reference standards and is interpreted as evidence of chronic malnutrition. Z-scores for height-for-age below the median by two standard deviations signal either risk or cases of chronic energy stress. However, it must be ruled out that low HAZ scores are not attributed to extremely short parents for the population. Short stature can result from stunted skeletal growth brought on by economic and environmental influences, or infection. When patterns of stunting, but not wasting, are found, short-term energy deficiency is not usually to blame. Low height-for-age (HAZ) in the general population (spanning all ages) could be associated with poor economic conditions rather than immediate dietary or disease stress (Keller 1991), although they are not mutually exclusive. Because periods of compensatory growth are slower for stature than weight, lingering effects are noted and can result in individuals stunted for their corresponding weight and age.

Body Mass Index (BMI) is considered useful in predicting morbidity, reduced work capacity, and risk of mortality in adults (Ferro-Luzzi et al. 1992). Summed triceps and subscapular skinfolds (Z2Skin) can average out some of the possible measurement errors (Garn et al. 1986). This index assesses body fatness and a low score indicates severe and acute energy stress. Measures of arm muscle area (AMA) are standardized to assess muscularity of individuals. These measures provide information about whether subjects experience acute protein malnutrition. Z-scores for AMA below -2.0 suggest low arm muscularity.

Child Nutritional Status

Descriptive Analysis

Anthropometric measurements over all five quarters of study are analyzed to assess general nutritional status of the Tsimane' children in the two communities. The sample size reflects the number of children in each age group with measures of weight (Table 8-2). Sample size varies between some measurements for two principle reasons. First, some children were missing a measurement such as a skinfold because of their young age or refusal to be measured during the anthropometric module. This occurred more frequently in Yaranda, where children were less comfortable being held by the researchers and the equipment set-up appeared similar to the vaccination campaigns.

Table 8-2. Sample size of children by community

	Girls		Boys		Total	
Community	n	%	n	%	n	%
San Antonio	47	51%	45	49%	92	57%
Yaranda	35	51%	34	49%	69	43%
Both Communities	82	51%	79	49%	161	100%

Second, I reviewed the values for each measurement prior to analysis to identify any implausible values, typically underestimations. I referred back to the original copy of the data, compared the value and when necessary deemed the measurement in error, replacing it with a missing value. This affected 19 specific measurements of heights in children under age two where supine length values were clearly in error when compared to the other quarters of observation of the same child. Eliminating some height values for the data also affected indices of weight-for-height and height-for-age.

A summary of the first measurement of anthropometric dimensions on children during the study is presented in Table 8-3. Statistically significant differences in measurements between girls and boys of the same age cohort are indicated. I find no

systematic pattern that would indicate gender differences in any one measurement, other than perhaps higher fat stores among girls (Sum2Skin).

Table 8-3. Anthropometric dimensions of Tsimane' children under 11 years of age

Age	n[22]	Stature (cm)	Weight (kg)	BMI (kg/m^2)	Sum2Skin (mm)	AMA (cm^2)
Girls						
0-0.9	16	57.0 ± 8.4	5.1 ± 1.7	16.5 ± 4.6	15.6 ± 5.7	9.7 ± 4.7
1.0-1.9	9	74.2 ± 3.7*	8.9 ± 0.6**	16.7 ± 1.6	12.7 ± 3.6	12.4 ±1.6
2.0-2.9	12	84.5 ± 4.2	11.7 ± 1.2	16.4 ± 1.2	14.8 ± 2.2**	13.4 ±1.5
3.0-3.9	5	94.7 ± 9.7	13.8 ± 2.6	16.4 ± 1.9	12.2 ± 3.3	13.9 ±1.5
4.0-4.9	7	98.9 ± 4.5	15.2 ± 1.7	15.5 ± 0.7	12.1 ± 2.1	15.3 ±2.2
5.0-5.9	4	100.4 ± 3.5	15.7 ± 0.6	17.2 ± 3.8	11.0 ± 1.9	17.9 ±2.4
6.0-6.9	3	108.4 ± 4.6	19.3 ± 4.6	16.3 ± 2.5	14.3 ± 6.9*	16.5 ±1.9
7.0-7.9	7	110.5 ± 4.3***	24.0 ± 3.3***	16.6 ± 0.7	10.6 ± 1.5	17.6±2.5*
8.0-8.9	9	121.6 ± 3.8	22.8 ± 1.8**	15.4 ± 1.1**	12.4 ± 2.7	19.6±2.4*
9.0-9.9	7	128.0 ± 8.6	27.5 ± 4.8	16.7 ± 1.3	16.6 ± 6.1**	21.8 ±3.3
10.0-10.9	3	129.5 ± 10.2	28.1 ± 3.7	16.8 ± 0.4	14.2 ± 3.2	25.9 ±7.2
Boys						
0-0.9	14	56.6 ± 6.6	5.1 ± 0.4	15.6 ± 1.5	14.0 ± 4.7	12.1±3.7
1.0-1.9	9	78.9 ± 6.0	10.2 ± 1.6	16.7 ± 1.8	11.3 ± 1.9	12.9 ±1.5
2.0-2.9	5	86.2 ± 3.8	11.9 ± 0.8	16.0 ± 0.7	11.7 ± 2.8	13.5 ±1.4
3.0-3.9	5	93.8 ± 2.9	14.2 ± 1.0	16.2 ± 0.9	11.3 ± 2.7	14.0 ±1.8
4.0-4.9	7	99.7 ± 6.3	16.2 ± 3.0	16.7 ± 2.4	12.2 ± 3.0	15.7 ±2.8
5.0-5.9	7	104.3 ± 6.4	17.5 ± 2.1	16.0 ± 0.9	10.7 ± 1.8	16.8 ±1.8
6.0-6.9	10	110.2 ± 4.8	18.9 ± 1.2	16.2 ± 2.2	10.3 ± 1.9	18.2 ±2.1
7.0-7.9	5	119.8 ± 6.2	19.2 ± 2.0	15.7 ± 1.3	9.7 ± 1.3	20.7 ±3.4
8.0-8.9	6	126.0 ± 9.6	26.9 ± 5.4	17.6 ± 2.6	11.8 ± 2.7	23.7 ±5.5
9.0-9.9	7	124.5 ± 3.8	25.9 ± 1.0	16.7 ± 0.6	11.4 ± 1.7	22.5 ±4.7
10.0-10.9	4	134.1 ± 7.3	30.8 ± 6.1	17.0 ± 1.7	11.6 ± 1.9	25.9 ±7.2

All values are Mean ± SD; Differences between girls and boys are statistically significant at :*P<0.10; **P<0.05; ***P<0.01

Standardized Indices of Nutritional Status

Table 8-4 presents a general overview of anthropometric characteristics of Tsimane' girls and boys under age 11 during the entire study. I first calculated average anthropometric indices for each individual over all quarters they were present in the sample. Next, I averaged the results to arrive at a general picture of how

[22] Sample of children for measurement of weight (kg).

Table 8-4. Anthropometric data for Tsimane' children by gender and community (age less than 11 years)

	Girls		Boys	
Measure	n	Mean ± SD	n	Mean ± SD
WHZ				
San Antonio	47	0.01 ± 0.71	45	0.16 ± 0.69
Yaranda	33	0.41 ± 0.42	34	0.46 ± 0.73
Both	80	0.18 ± 0.64	79	0.29 ± 0.72
WAZ				
San Antonio	46	-0.78 ± 0.73	45	-0.72 ± 0.80
Yaranda	33	-1.10 ± 0.78	32	-0.74 ±0.93
Both	79	-0.92 ± 0.76	77	-0.73 ± 0.85
HAZ				
San Antonio	46	-1.13 ± 1.04	45	-1.23 ± 0.98
Yaranda	31	-2.02 ± 0.99	32	-1.58 ± 1.13
Both	77	-1.48 ± 1.11	77	-1.37 ± 1.05
ZAMA				
San Antonio	40	-0.19 ± 0.53	39	-0.08 ± 0.68
Yaranda	32	0.06 ± 0.59	31	-0.34 ± 0.57
Both	72	-0.08 ± 0.57	70	-0.20 ± 0.65
Z2SKIN				
San Antonio	40	-0.79 ± 0.34	39	-0.83 ± 0.38
Yaranda	32	-0.64 ± 0.46	31	-0.62 ± 0.38
Both	72	-0.73 ± 0.05	70	-0.73 ± 0.39

Tsimane' children compare to international standards. Tsimane' children demonstrate overall adequate weight-for-height, with the average for both girls and boys above the median reference values from the U.S.. However, they compare poorly to standards of weight-for-age and even worse for height-for-age where average scores fall below one standard deviation. This pattern of moderate stunted height compared to international reference data, yet adequate short-term body composition has been found throughout the Amazon (Dangour 2003; Dufour 1992; Dufour 1994; Hodge and Dufour 1991; Holmes 1985; Orr et al. 2001; Stinson 1989; Stinson 1996).

Arm muscularity close to U.S. median values for both girls and boys suggest that Tsimane' children were not experiencing acute protein malnutrition during the research period. Average measures of subcutaneous fat stores (Z2Skin) for both girls and boys

fall below the median reference value, but do not approach severe depletion of fat stores. I did not detect any statistically significant differences in anthropometric characteristics between girls and boys (n.s.= P>0.10).

I compared results from the two-community panel study to those from the 58 community cross-section (Foster et al. n.d.). The cross-sectional survey included 409 children under age nine and drew from a much broader range of distance from market towns and participation the market economy. Children in the panel study have better WHZ, WAZ, and HAZ than and similar ZAMA to those in the cross-sectional study. Children in the panel have lower Z-scores for summed skinfolds than we found in the cross-section. The only statistically significant difference between girls and boys in the cross-section is for HAZ with girls doing better than boys.

Comparison of Amerindian Children

Comparative data on the nutritional status of other Amerindian children in tropical environments are available, but are not published in a standardized format or by consistent age groupings. Table 8-5 includes selected data on child height and weight from four Amerindian groups living under similar ecological conditions. The construction of age cohorts varies according to available data in the literature. From ages 1-1.9, Tsimane' girls compare similarly to the Shipibo of Peru and below the Chachi of Ecuador. Beyond age two, Tsimane' girls exceed both groups in weight and height. Average heights and weights of Tsimane' girls continue to rank above the Chachi through ten years of age. Tsimane boys have better weight and height than Shipibo boys in ages 1-3 years. Comparisons suggest that beyond the first year of life, Tsimane' boys are heavier and taller for their ages than the Chachi.

Table 8-5. Selected data on heights and weights of Amerindian children

		Weight (kg)		Height (cm)		
Amerindian Group	Ages	Girls	Boys	Girls	Boys	Source
Tukanoan, Ecuador	1.0-4.9	11.2	11.7	87.3	86.1	Orr et al. 2001
Tukanoan, Ecuador	5.0-9.9	19.3	20.1	108.6	108.4	Orr et al. 2001
Achuar, Ecuador	1.0-4.9	12.5	12.4	87.9	85.3	Orr et al. 2001
Achuar, Ecuador	5.0-9.9	19.4	21.5	110.2	113.8	Orr et al. 2001
Shipibo, Peru	1.0-1.9	8.8	8.4	74.4	72.3	Hodge & Dufour1991
Shipibo, Peru	2.0-2.9	10.7	10.2	81.2	79.8	Hodge & Dufour1991
Chachi, Ecuador	0.0-0.9	5.8	6.3	58.9	61.3	Stinson 1996
Chachi, Ecuador	1.0-1.9	9.8	10.1	76.4	75.8	Stinson 1996
Chachi, Ecuador	2.0-2.9	10.8	12.0	80.5	83.3	Stinson 1996
Chachi, Ecuador	3.0-3.9	13.1	14.2	88.7	90.4	Stinson 1996
Chachi, Ecuador	4.0-4.9	14.4	15.7	94.4	96.2	Stinson 1996
Chachi, Ecuador	5.0-5.9	13.4	15.7	97.6	102.0	Stinson 1989
Chachi, Ecuador	6.0-6.9	15.4	16.4	103.6	106.7	Stinson 1989
Chachi, Ecuador	7.0-7.9	17.2	18.8	109.0	110.5	Stinson 1989
Chachi, Ecuador	8.0-8.9	19.9	20.3	111.6	113.4	Stinson 1989
Chachi, Ecuador	9.0-9.9	20.7	22.3	118.5	116.5	Stinson 1989
Chachi, Ecuador	10.0-0.9	23.0	22.9	124.3	121.5	Stinson 1989

Very young Tsimane' girls and boys (1-4.99 years) compare less favorably in weight-for-height with Tukanoan and Achuar children (Tsimane' boys = 0.08; girls = 0.10 vs. Tukanoan and Achuar boys = 0.14; girls = 0.14) of the same age range in Ecuador (Orr et al. 2001). However, Tsimane' children between five and ten years of age do better than the other two groups (Tsimane', WHZ girls = 0.31; boys = 0.47 vs. Tukanoan, both sexes = 0.18 and Achuar, both sexes = 0.19). Among older children, Tsimane' girls and boys are generally taller and slightly heavier than Chachi children in age groups from 4.0-10.9 years of age.

Prevalence of Growth Deficits

Table 8-6 shows prevalence of growth deficits in girls and boys by season of measurement. There are more boys in the study than girls. Proportions of low HAZ are

higher for girls, but the absolute number of cases is the same. Risk of acute energy deficiency is low for Tsimane' children, however, evidence of long-term nutritional stress appears in HAZ. The high degree of stunting among girls and boys may be indicative of long-term compromised nutrition leading to impaired growth, yet short-term adequacy of diet. Stunting occurs over a longer-period than wasting and seasonal changes are probably attributed to changes in sample size. High loads of intestinal parasites and frequent bouts of diarrhea can also compromise growth. In Chapter 6, I found gastrointestinal disease to be the second most commonly reported illness for children.

Table 8-6. Mean and prevalence of Z-scores below -2SD cutoffs for anthropometric indices among Tsimane' children by season

			WHZ "Wasted"		HAZ "Stunted"		WAZ "Underweight"	
Quarter	Season	n	Mean	%	Mean	%	Mean	%
Girls								
1	Dry/Planting	50	-0.07	2%	-1.43	38%	-0.99	17%
2	Wet/Preharvest	58	0.19	2%	-1.45	32%	-0.90	10%
3	Wet/Harvest	56	0.28	0%	-1.42	27%	-0.79	3%
4	Dry/Fish	59	0.39	4%	-1.47	25%	-0.75	2%
5	Dry/Planting	69	0.05	0%	-1.35	27%	-0.92	4%
Boys								
1	Dry/Planting	52	0.09	0%	-1.30	34%	-0.83	9%
2	Wet/Preharvest	65	0.13	0%	-1.36	30%	-0.82	3%
3	Wet/Harvest	59	0.28	0%	-1.29	25%	-0.70	2%
4	Dry/Fish	61	0.43	0%	-1.29	25%	-0.59	0%
5	Dry/Planting	69	0.17	0%	-1.31	24%	-0.75	4%

Overall, the data show no evidence of severe wasting among Tsimane' children. The proportion of low WHZ for girls in Quarter 1, 2, and 4 is attributed to two young girls. One girl from San Antonio suffered severe illness during her first year of life (year prior to our study) and showed slow signs of recuperating – not even walking at two and a half years. The other girl experienced a severe drop in weight between Quarters 3 and 4 and her illness data show incidence of diarrhea for the entire week of recall. While the

Tsimane' children in general demonstrate adequate body composition, these cases remind us that they may still be prone to illness and declines in their context with low access to healthcare. There were no cases of wasting among boys during the research period. The adequate WHZ may be influenced by the high levels of low HAZ. Shorter or mildly stunted children could likely appear to be suitably heavy for their height (WHZ) under adequate present nutritional circumstances. The concentration of underweight children is higher for both sexes during the planting and preharvest season. The pattern during the planting season is unclear. Greater underweight during the preharvest season may relate to lower intakes of protein during these times as game returns are lower.

Child Growth and Development Compared

Linear growth

Distance charts showing attained height-by-age of the sample of children throughout the panel can be compared to reference data. Figures 8-1 and 8.2 show linear distance curves for Tsimane' girls and boys under age nine. Each figure presents linear growth of Tsimane' children compared to the U.S. 50th and 5th percentiles from the National Center for Health Statistics (Hamill et al. 1979).

The height curve for Tsimane' girls follows the U.S. 5th percentile until age five wherein it drops below the 5th percentile through age nine. Tsimane' boys start out below the 5th percentile until around age three when they improve and continue to track slightly above the 5th percentile. Our data do not show any evidence that Tsimane' girls or boys reach the median values of the reference population. Tsimane' shortness for age could be attributed to mild to moderate nutritional stress throughout childhood compared to reference populations.

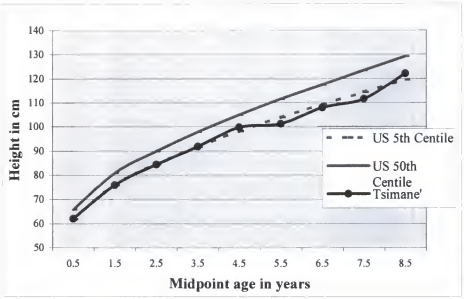

Figure 8-1. Comparison of height-for-age for Tsimane' vs. U.S. females (0-9 years)

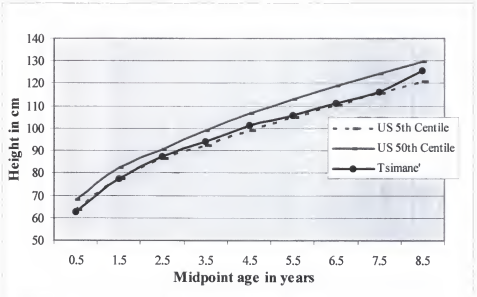

Figure 8-2. Comparison of height-for-age for Tsimane' vs. U.S. males (0-9 years)

Growth in body weight

Figure 8-3 shows that Tsimane' girls in the panel study follow the U.S. 5th percentile in weight for age until age two and a half wherein girls older than three years

demonstrate weight for age between the U.S. 50th and 5th percentiles. As depicted in the figure, Tsimane' girls do not reach the 50th percentile in height from birth to age ten.

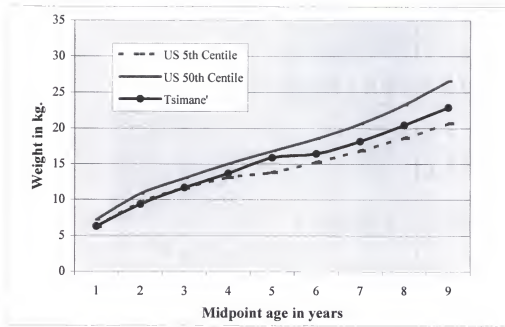

Figure 8-3. Comparison of weight-for-age for Tsimane' vs. U.S. females (0-9 years)

Very young Tsimane' boys compare more favorably to U.S. reference data on weight for age (Figure 8-4). As early as one year of age, male children have already achieved body weights above the 5th percentile. There is some evidence that at around age nine, boys approach and continue along median values. Compared with girls, boys have more favorable weights for their age (cf. Table 8-3). A comparison of weight and height growth charts confirms that catch up growth of Tsimane' children occurs more quickly for weight than stature. By two to three years of age, weights are already above the U.S. 5th percentile compared to heights, which remain close to or dip below the lower bound.

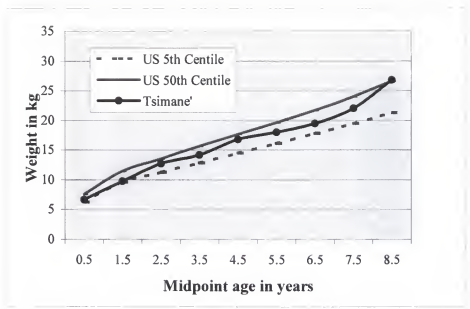

Figure 8-4. Comparison of weight-for-age for Tsimane' vs. U.S. males (0-9 years)

Multivariate Regression Analysis of Child Nutritional Status

In this next section, I test my hypothesis about the relationship between integration into the market, acculturation, and child nutritional health:

> *Hypothesis* #6 Children living in households more integrated into the market economy and with more acculturated parents, specifically mothers, will demonstrate better nutritional status than their less-integrated counterparts.

Childhood growth is affected by social, demographic, and economic factors (Frongillo et al. 1997). Thus, I expect to see differences in nutritional status of children from households with greater economic resources. I ran several configurations of the model for child nutritional status. Independent measures of acculturation include measures of parents' education measured by highest grade studied in school. I examine household measures of market integration, as well as specific measures of maternal economic participation. I include monthly income, wealth, and credit. In each model I control for the partial effects community of residence (1 = San Antonio; 0 = Yaranda),

sex (1 = female, 0 = male), age, illness during the quarter of measurement, household size, and average daily rainfall.

First, I tested each model for heteroscedasticity in the error terms using the Cook-Weisburg test. In models where there was evidence of heteroscedasticity, I used a robust option to account for the violation of the assumption of equal (homoscedastic) variance in the error terms (Kennedy 1992). Next, I proceeded with the Breush and Pagan Lagrangian multiplier test for random-effects. This procedure tests whether it is appropriate to use a random-effects model or an Ordinary Least Squares (OLS) model. If the models did not conform to the assumptions of a random effects model, I ran an OLS. Random-effects models are more appropriate for capturing the effects of variables in the model that do not change over time (e.g., sex, community, education). The final test I conducted was the Hausman specification test for autocorrelation and violations of the prior assumptions of the random effects model. If the test was significant, then the random effects were autocorrelated with a variable in the regression and the model is probably misspecified for random effects analysis.

Household-level market integration

Model 1

Nutritional Status = log hholdincome + loghhold wealth + loghhcredit + mother's schooling + father's schooling + community +sex + age + age^2 + ill + hhsize + mean rainfall

Initially, I ran Model 1 on the entire sample of children younger than 11 years of age (results not shown). I did not detect a statistically significant relationship between any household-level measures of market integration and WHZ, HAZ, WAZ, or ZAMA, and I detected only weak evidence of a positive association between mother's schooling and WHZ ($P<0.10$). Father's schooling was negatively associated with HAZ ($P<0.01$)

and WAZ ($P<0.05$). I re-ran Model 1 separately for each gender (results not shown) and also found no evidence of significant effects of household income, wealth, or credit on any of the four measures of child nutritional status.

Next, I split the analysis of children between the very young (0-4.99 years) and older children (5-10.99 years) to examine possible relationships between market integration, acculturation, and the nutritional status of children under five years of age. Under-five morbidity and mortality are common indicators of child health because the conditions of early childhood growth affect future physiological development. Table 8-7 displays results from Model 1 on young children.

Table 8-7. Results from random effects model of the effect of household-level market integration, parental acculturation and control variables on child nutritional status (Model 1; ages 0-4.99 years)

	Measures of Nutritional Status			
Independent Variable	WHZ	HAZ	WAZ	ZAMA
Sample Size	n=80	n=76	n=78	n=64
Observations	249	235	249	198
Market Integration				
Log Household Income	-0.01	0.00	0.00	0.01
Log Household Wealth	-0.14	-0.09	-0.11	-0.07
Log Household Credit	0.00	0.00	0.00	-0.01
Acculturation				
Mom grade	0.09	0.10	0.10	0.05
Dad grade	-0.02	-0.11**	-0.07*	-0.03
Controls				
San Antonio	-0.37**	0.39	-0.00	-0.32**
Female	0.02	-0.11	-0.12	0.07
Age	-0.60***	-0.31	-0.77***	0.20
Age^2	0.13***	0.05	0.16***	-0.02
Ill	0.03	0.03	0.02	-0.02
Household size	-0.04	0.13	0.03	0.02
Mean Rainfall for Quarter	0.00	-0.00	0.00	0.00
Constant	1.57	-0.73	0.41	0.20

Significance levels: *P<0.10; **P<0.05; ***P<0.01

The sample of children under age five was 80 with a total of 249 observations over the five quarters of measurement. Household measures of market integration did not

predict any of the four measures of nutritional status among young children. Contrary to my hypothesis, mother's education showed no significant effect. Father's schooling showed some evidence of a negative correlation with HAZ ($P<0.05$) and WAZ ($P<0.10$) in young children. A community effect is apparent with children in San Antonio predicted to have lower WHZ by 0.37 and lower ZAMA by 0.32 standard deviations ($P<0.05$) than children in Yaranda.

Results from Model 1 for older children are presented in Table 8-8. There is no evidence of partial effects of measures of household market integration. There is only weak support for a very small negative effect of household income on HAZ. Mother's schooling shows a positive effect only on ZAMA ($P<0.05$). Residence in San Antonio is positively correlated with HAZ and ZAMA.

Table 8-8. Results from random effects model of the effect of household-level market integration, parental acculturation and control variables on child nutritional status (Model 1; age 5-10.99 years)

	Measures of Nutritional Status		
Independent Variable	WHZ	HAZ‡	ZAMA‡
Sample Size	n=80	n=79	n=80
Total Observations	261	260	264
Market Integration			
Log Household Income	0.01	-0.01*	-0.01
Log Household Wealth	-0.02	0.00	-0.06
Log Household Credit	0.01	-0.00	-0.00
Acculturation			
Mom grade	0.09	0.01	0.09**
Dad grade	0.05	-0.08	0.03
Controls			
San Antonio	-0.12	0.57**	0.41***
Female	-0.12	-0.40**	0.02
Age	0.63**	0.18***	-0.01
Age^2	-0.04**	--	--
Ill	-0.12**	-0.01	-0.07
Household size	0.02	0.01	-0.03
Mean Rainfall for Quarter	-0.00	-0.00	0.01
Constant	-1.96	-2.90	0.35

Significance levels: *P<0.10; **P<0.05; ***P<0.01; Robust models noted with ‡ symbol

Similar to the analysis in Chapter 6, I also investigated whether the measures of market integration and acculturation act together in overlying factors. I found no statistically significant relationship between factors of market integration or parental acculturation and any of the four measures of nutritional status among younger or older children.

Maternal market integration

Model 2

Nutritional Status = log momincome + log not momincome + logmomwealth + log not momwealth + mother's schooling + father's schooling + community + sex + age + age^2 + ill + hhsize + mean rainfall

Model 2 specifically examines any partial effect of mothers' integration into the market. Table 8-9 displays results of Model 2 on the sample of young children. Elsewhere, maternal economic activity has been shown to have a positive impact on child nutritional status, but our data do not find that association. Strong negative associations are found between paternal education and HAZ ($P<0.01$) and WAZ ($P<0.05$) of young children. These findings are unclear because HAZ reflects long-term conditions of poor nutrition while WAZ reflects more proximate circumstances.

Results from Model 2 on older children (5-11 years) do not provide any support for a significant association between mother's income or wealth on the nutritional status of older children (Table 8-10). The coefficients for mother's income are close to zero. Mother's schooling is positively associated with WHZ ($P<0.10$) and ZAMA ($P<0.05$) in older children. I found no indication that mothers' integration into the market has any statistically significant ($P<0.10$) partial effect on the nutritional status of their children.

Table 8-9. Results from random effects model of the effect of maternal market integration, parental acculturation and control variables on child nutritional status (Model 2; ages 0-4.99 years)

	Measures of Nutritional Status			
Independent Variable	WHZ	HAZ	WAZ	ZAMA
Sample Size	n=73	n=71	n=73	n=58
Total Observations	240	232	247	189
Market Integration				
Log of mother's income	0.00	-0.01	-0.01	-0.02*
Log of other's income	-0.01	0.01	0.01	0.03
Log of mother's wealth	0.06	0.00	-0.06	-0.02
Log of other's wealth	-0.18	-0.12	-0.10	-0.07
Acculturation				
Mom grade	0.11*	0.09	0.11	0.03
Dad grade	-0.02	-0.12***	-0.08**	-0.02
Controls				
San Antonio	-0.39**	0.43	0.13	-0.18
Female	-0.02	-0.13	-0.15	0.09
Age	-0.65***	-0.27	-0.83***	0.11
Age^2	0.14***	0.04	0.18***	-0.01
Ill	-0.01	0.14	0.04	0.06
Household size	0.05	0.03	0.02	-0.00
Mean Rainfall for Quarter	0.00	-0.00	0.01	0.01
Constant	.38	-0.55	0.63	0.17

Significance levels: *P<0.10; **P<0.05; ***P<0.01

Discussion of Findings on Child Nutritional Status

In summary, the analysis of child nutritional status revealed opposite patterns of effects of parental acculturation. Mother's education was only significantly associated with WHZ of young children and both WHZ and ZAMA of older children. Each additional grade studied by a child's mother predicted higher Z-scores by 0.08-0.11 standard deviations on the two measures. I expected the effect of maternal education to be larger and more consistent across all four indices of child nutritional status. Conventionally, maternal education and literacy are positively associated with child health based on the argument that education and knowledge enable mothers to make better health-promoting choices about their child's care. The overall low level of

women's formal education may explain the weak findings. The variation in highest grade for Tsimane' mothers is low, spanning up to only fifth grade. The majority (~70%) of women in the sample do not have any formal education. Mothers are more homogenous in their educational attainment than fathers and the lack of variation in schooling may wash out any beneficial effect.

Table 8-10. Results from random effects model of the effect of maternal market integration, parental acculturation and control variables on child nutritional status (Model 2; ages 5-10.99 years)

	Measures of Nutritional Status			
Independent Variable	WHZ	HAZ‡	WAZ‡	ZAMA‡
Sample Size	n=77	n=77	n=77	n=77
Total Observations	270	270	273	273
Market Integration				
Log of mother's income	0.01	-0.01***	-0.00	-0.00
Log of other's income	0.01	0.00	-0.00	-0.00
Log of mother's wealth	0.0	-0.04	0.02	-0.08**
Log of other's wealth	0.01	-0.01	-0.02	0.00
Acculturation				
Mom grade	0.11*	0.01	0.06	0.08**
Dad grade	0.05	-0.09**	-0.03	0.02
Controls				
San Antonio	-0.17	0.67***	0.26	0.52***
Female	0.09	-0.37*	-0.30	0.03
Age	0.58**	-0.18***	0.62***	-0.23
Age^2	-0.04**	--	-0.03***	0.02
Ill	-0.12**	-0.01	-0.08***	-0.08
Household size	0.02	0.00	-0.01	-0.03
Mean Rainfall for Quarter	-0.00	0.00	-0.00	0.02***
Constant	-2.03	-2.62	-3.23	0.90

Significance levels: *P<0.10; **P<0.05; ***P<0.01; Robust models noted with ‡ symbol

In traditional societies, health knowledge may be handed down by generation and follow rules of thumb (Arora 2001). Our independent measure of knowledge or education by formal schooling may overlook actual differences in human capital related to health knowledge and illness prevention. Maternal education among the Tsimane' may not be a good proxy for health and nutritional knowledge. These are adults that

spent only one to two years is school. Their lifetime of knowledge about health and nutrition is not likely to be well represented in our independent variable.

My analysis found father's education negatively associated with HAZ, WAZ in all models. This unpredicted finding is complex to interpret. One speculative explanation that I can offer as to why paternal education would be detrimental is that greater acculturation may influence decisions and allocations of fathers away from direct investment in their children towards market valued luxury items and novelties. Another may be related to age and educational attainment. Among adult males, age and school grade are negatively correlated ($r = -0.55$). Younger males tend to have completed higher grades in formal schooling. Combined with possible generational differences in preferences for market items and opportunities for employment, education and age may work to hinder child nutritional status.

For fathers, more education may also proxy greater market involvement, acceptance of external values, and contact with missionaries and other towns people. Perhaps an unobserved link between greater exposure to external culture and schooling translates back to negatively affect the nutritional status of children. Exposure to outside influences may result in the allocation of household resources in a manner than somehow undermines child well-being.

After testing different configurations of market integration at the household-level I found no evidence of an association with the nutritional status of either younger or older children. Other factors must therefore be more important. Community differences are strong, but inconsistent in the direction of association. Younger children fare worse on WHZ and ZAMA in the San Antonio ($P<0.05$), while older children fare better in San

Antonio on HAZ and ZAMA ($P<0.05$). Unmeasured factors such as the quality of the water supply, ecological variation, and individual dietary intake may likely be at play in determining differences in child nutritional status. In sum, the results did not produce any evidence that household market integration is either negatively or positively related to nutritional status.

Adult Nutritional Status

Descriptive Analysis of Adult Nutritional Status

Summary analysis and community comparisons of the nutritional status of Tsimane' women and men are presented in Tables 8-11 and 8-12. I calculated group averages from the analysis of averaged measures for each female and male over 18 years of age over five quarters to provide a descriptive summary of adult Tsimane' body size. For the summary analysis, I excluded measures from any woman who reported being pregnant at the time of measurement to reduce error attributed to body changes accompanying pregnancy. On average during any one quarter 15-29% of the sample of women were pregnant and 17-23% were lactating. I ran t-tests to test for differences in average measures of individual nutritional status between communities.

Nutritional Status of Tsimane' Women

Overall, Tsimane' women demonstrate good nutritional status. Measures of BMI for Tsimane' women fall within the normal range for women with an average BMI of 22.9 for the total sample. Acceptable "normal" ranges for BMI are 18.7-23.8 for women (James and Schofield 1990). There are no apparent community-level differences in women's BMI. Compared to international reference standards, the average Tsimane' women's weight-for-height Z-score falls below the median value for adult women with an average of 0.6 standard deviations below the U.S. median value. Nevertheless, this

does not approach wasting levels (WHZ<-2.0). Women living in San Antonio are significantly (P<0.001) taller than women in Yaranda by an average of 5 cm.

Table 8-11. Summary of anthropometric data of adult females 18 years and older by community

	San Antonio (n=31)		Yaranda (n=23)		Total (n=54)		Between Community	
Measures	Mean	SD	Mean	SD	Mean	SD	t	p
Height (cm)	153.4	5.4	148.5	3.6	151.3	5.2	-3.8	0.00
Weight (cm)	52.9	6.9	52.5	7.2	52.3	7.0	-0.7	0.49
BMI (kg/cm^2)	22.5	3.0	23.3	3.0	22.9	3.0	1.0	0.31
WHZ (Z-score)	-0.7	0.5	-0.6	0.5	-0.6	0.5	0.3	0.77
AMA (cm^2)	41.1	7.0	37.5	6.9	39.6	7.2	-1.9	0.07
ZAMA (Z-score)	0.8	0.7	0.4	0.7	0.6	0.7	-2.9	0.03
Sum2Skinfolds (mm)	28.6	9.5	35.1	9.1	31.3	9.8	2.5	0.01
ZSum2Skin (Z-score)	-0.8	0.58	-0.5	0.58	-0.6	0.6	2.0	0.05
Triceps Skinfolds (mm)	13.9	4.5	18.3	4.7	15.8	5.0	3.5	0.00
Bicep Skinfolds (mm)	5.9	2.8	6.7	2.4	6.2	2.7	1.1	0.26
SubScapular (mm)	14.6	5.3	16.7	5.1	15.5	5.3	1.5	0.15
Suprailiac (mm)	16.0	5.4	18.4	4.8	17.0	5.2	1.7	0.10

*Pregnant women excluded from sample analysis

Measures of arm muscle area (ZAMA) in Tsimane' women compared to reference standards are above the median as well. There is no evidence of acute protein malnutrition among adult women. Average Z-scores on summed skinfolds fall below the median for women indicating low subcutaneous fat stores by comparison. Significant community-level differences in women's anthropometric measurements are found in height, (P<0.001), AMA (P<0.07), and ZAMA (P<0.03) with women from San Antonio having larger values. Average measures of summed skinfolds (P<0.01), Z-score for summed skinfolds (P<0.05), and triceps (P<0.001) are significantly higher for women in Yaranda. These findings suggest greater fat reserves for women in Yaranda. Differences

in energy expenditure and/or energy intake between communities may account for these differences.

There is some indication of interobserver error/bias between skinfold measurements taken in San Antonio and Yaranda, specifically in measurement of triceps skinfold thickness. It appears that triceps skinfolds were measured larger in Yaranda than San Antonio. If so, this would affect the calculation for the upper AMA and the sum of two skinfolds index because the formula incorporates raw skinfold measurements (triceps + subscapular). It is unclear if the significant community-level differences on triceps, sum of two skinfolds, and AMA are attributed to measurement differences rather than actual differences in fat stores and lean tissue mass. To investigate community-level differences, I compared data on women from San Antonio and Yaranda from the 58-community cross-section survey that included measurements of 12 randomly picked adults in San Antonio and Yaranda by two independent teams. A similar pattern of higher skinfold values for women in Yaranda in the cross-section would support the argument of verifiable community differences. I ran the small sample of women in the cross-sectional survey from each community and did not detect significant differences in any of the skinfold measurements, which strengthens the possible argument for measurement error. Nevertheless, analysis of men's anthropometric characteristics finds men in Yaranda to be heavier and fatter, so that the women would also be heavier is not without possibility.

Nutritional Status of Tsimane' Men

There are no statistically significant differences in men's average height or weight between communities. When taken together as an index of body composition, men in Yaranda are heavier for their heights than in San Antonio ($P<0.001$) and have a higher

BMI (P<0.001). Men from both Yaranda and San Antonio fall within the "normal" range of 20.5-25 (James and Schofield 1990) with an average BMI of 23.0. Compared to international standards, Tsimane' men are below the median in weight-for-height (-0.6). Similar to the women, Tsimane' men are thinner for their heights than the median value for the reference population. The average Z-score for males on AMA is only slightly below the U.S. median.

Table 8-12. Summary of anthropometric data of adult males by community (18 years and older)

	San Antonio (n=39)		Yaranda (n=34)		Total (n=73)		Between Community	
Measures	Mean	SD	Mean	SD	Mean	SD	t	p
Height (cm)	164.7	5.0	163.1	3.8	164.0	4.5	-1.5	0.13
Weight (cm)	60.9	5.8	63.2	5.7	62.0	5.8	1.7	0.10
BMI (kg/cm^2)	22.4	1.4	23.7	1.8	23.0	1.7	3.5	0.00
WHZ (Z-score)	-0.8	0.3	-0.5	0.4	-0.6	0.4	3.3	0.00
AMA (cm^2)	52.7	6.2	51.7	6.3	52.3	6.2	-0.7	0.50
ZAMA (Z-score)	-0.1	0.6	-0.1	0.5	-0.1	0.5	-0.6	0.57
Sum2Skinfolds (mm)	14.2	3.2	19.6	5.8	16.8	5.3	4.9	0.00
ZSum2Skin (Z-score)	-1.0	0.3	-0.6	0.4	-0.8	0.4	4.6	0.00
Triceps Skinfolds (mm)	6.2	1.6	8.3	2.9	7.2	2.5	3.8	0.00
Bicep Skinfolds (mm)	2.8	0.8	4.0	1.3	3.4	1.2	4.5	0.00
SubScapular (mm)	8.0	1.9	11.3	3.2	9.6	3.1	5.3	0.00
Suprailiac (mm)	10.5	3.7	10.2	4.0	10.4	3.8	-0.2	0.86

The analysis reveals strong consistent statistical evidence (P<0.001) of community-level differences in men's nutritional status with men in Yaranda measuring higher on BMI, WHZ, summed skinfolds, triceps, biceps, and subscapular skinfolds. Possible explanations for heavier and fatter men in Yaranda may involve patterns of dietary consumption. Large quantities of *chicha* are consumed on a regular basis in Yaranda

compared with San Antonio. Greater intake of meat and fish may also lead to better higher caloric consumption of men in Yaranda. I ran a t-test on BMI between the men from each community measured in the cross-section and found the results to be consistent with the panel study. Men in Yaranda have significantly higher BMI ($P<0.01$) and weight ($P<0.10$) than men in San Antonio. This supports the findings and refutes any idea of measurement error among men.

Chronic Energy Deficiency (CED)

Average measures of adult body composition can mask individuals that fall at the extreme ends of the spectrum. Table 8-13 shows the percent of adults in each classification of BMI based on Chronic Energy Deficiency (CED) (Ferro-Luzzi et al. 1992). There were only a few Tsimane' adults with a BMI at levels indicating CED. Their specific cases are examined. Two women from San Antonio fall into Grade II CED, but no men from the sample are classified as such. At closer inspection, the two women are an elderly woman physically confined to her residence and a mother with five children who was breastfeeding for part of the study period. In Yaranda two women are classified at Grade II, a 77 year-old woman and a 42 year-old who later died in December 2001. One older male in San Antonio who suffers from tuberculosis yet continues to work his field and travel to San Borja is classified as Grade I CED. When encouraged by the research team to seek treatment, he responded that he could not find the time to go to town for extended treatment of tuberculosis. Apart from these five individuals, our data do not indicate that CED is a problem among Tsimane' adults in either community.

On the opposite end of the nutritional spectrum, more women (35%) than men (13%) fit the overweight classification. A pattern of higher levels of women in developing regions classified as overweight or obese has been attributed to their higher

levels of arm musculature compared with reference populations resulting from greater levels of physical activity and upper body strength (e.g., activity patterns of carrying children, pounding rice, steering canoes, carrying loads). Men living in Yaranda are heavier with 24% classified as overweight compared with only 3% in San Antonio. This provides additional support that men in Yaranda are heavier than men in San Antonio.

Table 8-13. Adult chronic energy deficiency (CED) by gender and community

		Women		Men	
Classification	BMI range	San Antonio (n=31)	Yaranda (n=23)	San Antonio (n=36)	Yaranda (n=33)
Grade III CED	<16.0	--	--	--	--
Grade II CED	16.0-16.9	6%	0%	--	--
Grade I CED	17.0-18.4	0%	8%	3%	0%
Normal	18.5-24.9	61%	52%	94%	76%
Overweight	25.0-29.9	32%	39%	3%	24%
Obese	30.0-39.9	--	--	--	--

Genders Compared

Men are leaner than women even when compared to the sex-specific reference data. Higher energy expenditures by males in agricultural activities, wage labor, transportation, and hunting and marketing trips may explain some of these differences. Women fare better than men in Z-scores for the sum of two skinfolds at 0.63 SD units below the reference values, while men are on average are 0.84 SD units below. Women also compare better for relative musculature (AMA) averaging above the U.S. 50th percentile (ZAMA = 0.64), while the men's average is below (ZAMA = -0.10). This suggests that on average women fare better than men in caloric reserves than men. However, overall, women have greater seasonal shifts in body weight through loss and replacement of fat stores. A complete seasonal analysis of nutritional status is beyond the scope of this dissertation.

Comparison with Other Amerindians

Data from studies of similar populations serve as a useful comparison of how Tsimane' adults measure up in terms of nutritional status. Compared to published data on other native South Americans populations (Coimbra et al. 2002; Dufour 1992; Hill et al. 1984; Holmes 1995), Tsimane' women and men fall somewhere near the taller and heavier end (Table 8-14). Sample sizes vary and most of the studies were conducted as one-time cross-sections. Having portrayed the general anthropometric characteristics of Tsimane' adults in our study, I now move on to the analysis and presentation of results from hypothesis testing about how market integration and acculturation relates to nutritional status.

Table 8-14. Heights and weights of selected Amerindian adults

	Weight (kg)		Height (cm)		
Amerindian Group	Women	Men	Women	Men	Source
Xikrin, Brazil	56.0	63.6	155.9	168.7	Black et al. 1977
Mekranoti, Brazil	56.4	66.6	153.1	166.4	Black et al. 1977
Tsimane', Bolivia	*52.3*	*62.0*	*151.3*	*164.0*	*Present study*
Ache, Paraguay	51.8	59.6	150.0	161.0	Hill et al. 1984
Waspishana, Guyana	52.4	60.5	149.8	160.5	Dangour 2003
Achuar, Ecuador	52.3	60.1	147.3	158.1	Orr et al. 2001
Suruí, Brazil	50.2	56.2	146.5	158.9	Santos & Coimbra 1996
Patamona, Guyana	48.3	57.8	146.2	158.2	Dangour 2003
Tukanoan, Colombia	49.9	59.3	146.1	156.7	Orr et al. 2001
Chachi, Ecuador	47.3	55.8	145.4	155.3	Stinson 1989
Machiguenga, Peru	42.8	52.3	142.8	157.4	Johnson & Behrens 1982
Curripaco, Venezuela	--	--	142.7	156.5	Holmes 1981
Barí, Venezuela	--	--	143.8	151.7	Holmes, 1981

Multivariate Analysis of Adult Nutritional Status

Hypothesis #7 More acculturated and market-integrated adults will demonstrate better nutritional status than less integrated adults.

I analyzed several models using random effects regression models for repeated measures to test my hypothesis about the relationship between market integration, acculturation and adult nutritional status. For each model, I used four different measures

of short-term nutritional status: BMI, WHZ, ZAMA, and Z2Skin as the dependent variables. I begin with the analysis of individual-level factors and measures of market integration and acculturation. Then I move to examine household-level factors and measures of market integration. Because the different aspects of market integration and acculturation may collectively influence adult nutritional status, I first conducted multivariate regression analysis of models that examine market integration and acculturation using factors of the principal components of each. Second, I analyzed nutritional status by the specific variables that are elements of each larger concept to identify aspects of market integration or acculturation that might specifically affect adult nutritional status.

Individual-level analysis

Model 1

Nutritional Status = α + MI factor + acculturation factor + community + sex + age + age^2 + ill + mean rainfall

Model 1 examines the effect of factors of individual acculturation and integration into the market and four different short-term measures of adult nutritional status. In Model 1, and all the ensuing models for adult nutritional status, I control for community (San Antonio = 1, Yaranda = 0), sex (1,0), age, age-squared when there is a significant curvilinear relationship, whether or not the individual reported an illness during the illness recall each quarter, and average daily rainfall in each community during the quarter of measurement to account for seasonality. Results from Model 1 do not provide evidence of statistically significant effects (below the 90% confidence level) of individual market integration or acculturation on any of the four measures of short-term nutritional status (not shown).

As I did not find any evidence of significant effects of individual factors of market integration and acculturation, I ran a different model (Model 2) using two factors of market integration to examine whether more specific elements of market integration may be at play. I substituted two factors representing different elements of market integration (cash wealth factor and in-kind credit factor) for the single factor for individual market integration. The first factor accounts for correlation between effects of individual cash income and wealth. The second factor represents individual in-kind income and credit taken.

Model 2

Nutritional Status = α + cashwealth factor + kindcredit factor + acculturation factor + community + sex + age + age^2 + ill + mean rainfall

Model 2 provides weak statistical support that the cash/wealth factor of market integration correlates with higher BMI ($P<0.10$) and strong evidence that it correlates with a small increase in the Z-score for summed skinfolds ($P<0.01$) (Table 8-15). The factor for in-kind income and credit does not have any statistically significant importance for nutritional status. A significant ($P<0.05$) community effect, however, is apparent. Controlling for all other covariates in the model, residency in San Antonio predicts lower BMI by 1.45, lower WHZ by 0.24, lower Z-score for summed skinfolds by 0.48, and higher ZAMA by 0.22 standard deviations. Evidence of a seasonal effect suggests lower measures of nutritional status during the wetter seasons.

The lack of evidence that individual-level factors of acculturation and market integration correlate with adult short-term nutritional status gives no reason to continue with the analysis using the components (variables) of each factor. Instead, I ran the analysis of partial effects of direct measures of cash income, in-kind income, traditional

wealth, and modern wealth (Model 3). The results (not shown) confirm only weak ($P<0.10$) evidence that an individual's modern wealth correlates with higher BMI and WHZ. No other statistically significant relationship is found. In the same manner, individual measures of schooling and the ability to speak Spanish showed no indication of significant effects.

Table 8-15. Results from random effects Model 2 on type factors of individual adult market integration and acculturation

	Measures of Nutritional Status			
Independent Variables	BMI	WHZ	ZAMA	Z2Skin‡
Sample Size	n=122	n=121	n=122	n=122
Observations	445	444	445	445
Market Integration				
CashWealth Factor	0.10*	0.01	-0.01	0.03***
KindCredit Factor	-0.05	-0.01	-0.03	-0.01
Acculturation				
Acculturation Factor	0.08	0.04	0.06	-0.04
Controls				
San Antonio	-1.45***	-0.24***	0.22**	-0.48***
Ill	-0.12*	-0.02	0.02	-0.03
Female	0.18	0.07	0.02	0.34***
Age	0.16*	0.04***	-0.01**	-0.02***
Age^2	-0.00**	-0.00	--	--
Mean Rainfall/Quarter	-0.06***	-0.01***	0.00	-0.02***
Constant	21.36	-1.14***	0.17	0.08

Significance levels: *P<0.10; **P<0.05; ***P<0.01; Robust models noted with ‡ symbol

Model 3 (results not included)

Nutritional Status = α + log of cash income + log of in-kind income + log modern wealth + log of traditional wealth + Spanish + highest grade + community + sex + age + age^2 + ill + mean rainfall

Household-level analysis of adult nutritional status

The results from individual-level analysis did not reveal any significant effects of market integration and acculturation measured on the short-term nutritional status of Tsimane' adults. Therefore, I shift the focus to household-level of analysis (Model 4).

Model 4

Nutritional Status = α + Hhold MIfactor + acculturation factor + community + sex + age + age^2 + ill + mean rainfall

Model 4 analyzes adult nutritional status by a single factor of household market integration. It is reasonable to suggest that the total income, wealth, and credit of adult members of a household influence the nutritional status of other members living in the household. Results from Model 4 (Table 8-16) demonstrate evidence of a positive

Table 8-16. Results from random effects Model 4 on factors of household market integration and adult acculturation

	Measures of Nutritional Status			
Independent Variables	BMI	WHZ	ZAMA	Z2Skin‡
Sample Size	n=124	n=124	n=124	n=124
Observations	451	450	451	451
Market Integration				
Hhold income wealth factor	0.13**	0.03**	-0.01	0.04**
Acculturation				
Acculturation Factor	0.07	0.03	0.04	-0.04
Controls				
San Antonio	-1.44***	-0.24***	0.20*	-0.47***
Female	0.09	0.07	0.79***	0.31***
Age	0.15*	0.03**	-0.01***	-0.02***
Age^2	-0.00**	-0.00***	--	--
Ill	-0.13*	-0.02	0.03	-0.04
Mean Rainfall for Quarter	-0.06***	-0.01***	-0.00	-0.02***
Constant	21.42	-1.06	0.21	0.09

Significance levels: *P<0.10; **P<0.05; ***P<0.01; Robust models noted with ‡ symbol

correlation between the factor for household market integration and three of the four measures of adult nutritional status: BMI, WHZ, and Z2Skin (P<0.05). Controlling for all other variables in the model, a one point increase in the score for the household factor

predicts a 0.13 increase in BMI, a 0.03 increase in WHZ, and a 0.04 increase in Z-score for summed skinfolds. This suggests that adults living in more integrated households have higher predicted measures of nutritional status.

In order to look into the principal components of the factor on household market integration, I ran Model 5 on household measures of wealth, income, and credit.

Model 5

Nutritional Status = α + Log household wealth + Log household income + Log household credit + Spanish + Highest grade + community + sex + age + age^2 + ill + mean rainfall

Results from Model 5 illuminate the characteristics of household market integration that may account for the findings in Model 4. The results (Table 8-17) suggest that

Table 8-17. Results from random effects Model 5 household measures of market integration and individual acculturation

	Measures of Nutritional Status			
Independent Variables	BMI	WHZ	ZAMA	Z2Skin
Sample Size	n=124	n=123	n=124	n=124
Observations	447	446	447	447
Market Integration				
Log of Household wealth	0.22**	0.06***	0.04	0.05
Log of Household income	0.02	0.00	0.01	0.01**
Log of Household credit taken	-0.02***	-0.01***	0.00	-0.00
Acculturation				
Spanish	-0.74	-0.13	-0.01	-0.14
Highest grade	0.17	0.04	0.03	0.01
Controls				
San Antonio	-1.22***	-0.20**	0.21*	-0.44***
Ill	-0.13*	-0.02	0.04	-0.03*
Female	-0.07	0.04	0.789***	0.29***
Age	0.20**	0.04***	-0.01***	-0.02***
Age^2	-0.00**	-0.00***	--	--
Mean Rainfall for Quarter	-0.05***	-0.01***	-0.01	-0.02***
Constant	18.9	-1.70	-0.21	-0.25

Significance levels: *P<0.10; **P<0.05; ***P<0.01; Robust models noted with + symbol
household wealth is correlated with higher adult BMI (P<0.05) and WHZ (P<0.01).

The coefficients are interpreted to show that a 1% increase in household wealth correlates with a higher BMI by 0.22 and 0.06 greater WHZ. I also found evidence of a small negative relationship between the amount of debt a household incurred through credit and BMI and WHZ ($P<0.01$). There is no strong relationship between household monthly income and any of the measures of adult nutritional status, barring a small positive correlation with Z-score for summed skinfolds. Essentially, the results indicate that there is no partial income effect. These findings contradict themes in the literature suggesting that income is the agent to better nutritional status.

Gender analysis

Finally, reflecting on household dynamics and elements of market integration, I considered whether the positive association between household wealth and nutritional status affects women and men in equally. While individual adult market integration showed no statistically significant relationship with nutritional status, household wealth, credit, and income (to a lesser extent) did. In the Tsimane' economy, the bulk of household income is earned by men and the material assets are usually acquired by men as well. Women in the sample are more homogenous on measures of market integration and acculturation than men, but more heterogeneous in measures of nutritional status. To examine gender differences on the effect of household market integration, I re-ran Model 4 using the household factor of market integration on gender-specific samples. Results from the two analyses are presented in Tables 8-18 and 8-19.

Any statistically significant effect of the factor for household market integration disappears in the sample of women. The acculturation factor shows only weak negative correlation with ZAMA ($P<0.10$). The effect of household income and wealth is absent

in the women's sample. There is no evidence that the nutritional status of adult women is improved as the household becomes more integrated.

Table 8-18. Results from random effects Model 4 on factors of household market integration and adult acculturation for women only

	Measures of Nutritional Status			
Independent Variables	BMI‡	WHZ‡	ZAMA	Z2Skin
Sample Size	n=61	n=60	n=61	n=61
Observations	201	200	201	201
Market Integration				
Household income wealth factor	0.15	0.02	0.03	0.03
Acculturation				
Acculturation factor	-0.65	-0.12	-0.23*	-0.09
Controls				
San Antonio	-1.59**	-0.18	0.21	-0.41***
Ill	-0.18	-0.04	-0.03	-0.06
Age	0.02	0.00	-0.05*	-0.02***
Age^2	-0.00	-0.00	0.00	--
Mean Rainfall for Quarter	-0.07	-0.01***	-0.01**	-0.02***
Constant	24.2	-0.38	1.90	0.51

Significance levels: *P<0.10; **P<0.05; ***P<0.01; Robust models noted with ‡ symbol

Table 8-19. Results from random effects Model 4 on factors of household market integration and adult acculturation, men only

	Measures of Nutritional Status			
Independent Variables	BMI	WHZ	ZAMA‡	Z2Skin‡
Sample Size	n=63	n=63	n=63	n=63
Observations	236	236	236	236
Market Integration				
Household income wealth factor	0.15**	0.04	-0.04	0.05*
Acculturation				
Acculturation factor	0.49**	0.12**	0.22***	0.01
Controls				
San Antonio	-1.44***	-0.33***	0.17	-0.53***
Ill	-0.10	-0.01	0.07	-0.02
Age	0.36***	0.09***	0.02	-0.01***
Age^2	-0.00***	-0.00***	-0.00	--
Mean Rainfall for Quarter	-0.05***	-0.01***	0.00	-0.02***
Constant	17.5	-2.00	-0.50	-0.08

Among men, higher scores for household MI factor are correlated with higher BMI ($P<0.05$) and skinfold thickness ($P<0.10$). Men's own acculturation exhibits a strong

positive correlation with BMI ($P<0.05$), WHZ ($P<0.05$), and ZAMA ($P<0.01$). Holding all other variables constant, more acculturated men have better nutritional status. The results also suggest that men benefit from household market integration more than women.

Discussion of Results from Adult Analysis

Individual level

Contrary to my hypothesis, I find little or no support that individual-level measures of adult integration into the market and acculturation are related to adult nutritional status. Individual acculturation significantly correlates with higher measures of nutritional status among men, but not for women. The real story appears to be found at the household rather than the individual-level. My hypothesis was not incorrect, per se, but was oriented toward the wrong level of analysis.

Household level

The household income and wealth factor is significantly correlated with three of the four short-term measures (Model 4). One interpretation is that adults living in more integrated households enjoy better nutritional status because of access to more food, better hygiene, and possibly lower energy expenditures. Results from Model 5 suggest that current wealth may be the most important component with respect to better nutritional status. The literature suggests that wealth may protect against shocks to nutritional status such as illness-related weight loss. Current wealth has been found elsewhere to positively affect adult BMI (Dangour 2003).

Possible confounds to this explanation exist because income and wealth are endogenous with health status. Presumably, healthier adults will have better abilities to earn income and accumulate and retain wealth. Better nutritional status may facilitate

greater participation in the market economy. My models take into account illness during the weeks before the measures of nutritional status, but not any illness prior to the month of economic activities the income and wealth surveys cover. In Chapter 4, I discussed how income in the Tsimane' economy is often more transitory compared to wealth. The greater variability in income may not act as a consistent beneficial or detrimental health effect.

The benefit of household wealth on adult nutritional status appears to be gender-specific. When analyzed separately, any significant effect of household wealth disappeared in the sample of women. To explore why household wealth would only benefit adult male nutritional status, I consider the gender division of labor within Tsimane' households. As households accumulate more material wealth, there is no correlation between decreased labor for women. None of the material assets acquired by households present labor-saving technologies. The preparation of daily meals, care of children, and washing of clothes are very labor intensive and incur high caloric costs by women. Our studied lacked any systematic collection of data on household expenditures and use of income, wealth, and credit. Future studies should include measurement of income expenditures, activity levels, and energy expenditures to help sort out these effects.

Community level

Adults in San Antonio have worse measures of nutritional status than adults in Yaranda. The community effect uncovered in this analysis can be interpreted as one proxy for greater integration via contact and proximity to the market town. The influences that come with residence close to the market town were described in detail in Chapters 3 and 4. This variable most likely captures other unobservable factors,

influences such as adoption of values, knowledge of non-Tsimane' cultures and worldviews. But even after controlling for community, household wealth still turns out to be significantly related to two measures of nutritional status.

While we did not measure energy expenditures or track individual physical activity by hours, we can infer that the larger agricultural plots ($P<0.00102$) per household and cultivated area ($P<0.0012$) in San Antonio (Vadez et al. 2003) require greater energy demands via labor investments during, cutting, preparation, and planting phases. The greater energy demands, principally on adult males, may influence body composition such that fat stores are depleted on a greater scale and lean muscle mass is made more apparent. Significant differences each quarter between Men's WHZ by community show that men in San Antonio are worse off every quarter.

Chapter Conclusion

The adult findings are consistent with several key points discussed earlier in this dissertation. Men earn the majority of the income and claim the majority of the material assets that compose household total income and wealth. Tsimane' adults and households demonstrate high variance in monthly income and wealth in our two communities (cf. Chapter 4), however, they show less variability in dependent measures of health. The present analysis suggests that market integration measured through income, credit, and wealth does not stratify Tsimane' households in terms of living standards. Regardless of level of market integration, most households have the same style and type of housing, comparable hygiene, water source, and dietary diversity. Tsimane' adults and households may appear dissimilar based on our measures of integration into the market economy, but they do not diverge so much in their general health status. Among adults, I found greater variance in anthropometric characteristics between women than men.

The differences in degree of integration into the market and acculturation that we found are apparently not important enough to initiate stratification in health and welfare. Household market integration does not appear to stratify children by nutritional indicators either. Out of this analysis, I conclude that the Tsimane' have not reached a level of market involvement and participation that would translate into any noticeable differences in nutritional status. Economic differentiation among the Tsimane' may not be marked enough to bring about noticeable differences in adult or child health measured through nutritional status.

Other members of our research team have suggested that redistribution and reciprocal behaviors may level out the disparities in resource acquisition. Earlier in the dissertation, I alluded to and now reiterate that any financial benefits of market integration are not being directly invested into improvement of household or individual welfare. The disposal of cash income in Tsimane' society is largely immediate and not necessarily directed toward investments in direct or indirect health-promoting activities, goods, or services. For example, more market-integrated individuals and households have acquired locks on their doors, nondurable goods such as clothing, and bikes. But all of these acquisitions are transitory resources given the ecological conditions in which they live. Periodic income does not predict any long-term or lasting impacts on health.

In sum, the absence of any important partial effect of household or individual income on measures of adult nutritional status may be attributable to the periodicity of Tsimane' income, especially for individuals (cf. Figure 4.2) and households in San Antonio. Household and individual incomes peak in Quarter 2 and drop during Quarter 3, the wet/preharvest season. Finally, another reason why we did not find huge effects is

that nutritional status may have been too short a time frame. Short-term income (monthly) may not be important enough to demonstrate longer trends in the relationship between market integration and adult or child nutritional health.

CHAPTER 9
CONCLUSIONS

General Discussion of Findings

This study set out to test the relationship between individual and household-level measures of integration to the market economy, social acculturation, and health of an indigenous group in the Bolivian Amazon. Specifically, the research was positioned to test whether greater participation in the market economy, accumulation of wealth, access to education, and other forms of assimilation would be associated with notable differences in physical health, dietary intake, and nutritional status. The Tsimane' of lowland Bolivia were a suitable population to examine the above issues. Past research indicates that accelerated contact, exposure, and participation in larger economies and societies has an impact on the livelihood of native peoples (Coimbra et al. 2002; Godoy and Cardenas 1998; Holmes 1985; Lawrence et al. 1980; Murray and Chen 1992; Wirsing 1985). Tsimane' individuals and households from the two study communities of San Antonio and Yaranda span a range of involvement in the wider economy and society. In the following sections I review the findings from my analysis and offer interpretations of their significance. Table 9-1 displays the research hypotheses tested in this dissertation and a general summary of the results from the multivariate analysis.

Self-Perceived Health

Contrary to my research hypotheses, I did not find any statistically significant association between measures of integration to the market and adult or child reported illness. I attribute the lack of any significant relationship between measures of market

Table 9-1. Summary of findings from analysis of effects of market integration and acculturation on measures of Tsimane health

Hypotheses	Dependent Variable	Market Integration	Acculturation	Community (San Antonio)
Self-Perceived Illness				
#1 Adults more integrated and acculturated will report more illness, longer duration, and severity.	Ill Days Ill Days in Bed	n.s. n.s. n.s.	(-) women; (n.s.) men (-) women; (n.s.) men (-) women; (n.s.) men	n.s. n.s. n.s.
#2 Children with more acculturated and market-integrated parents will have less illness, shorter duration, and lower severity.	Ill Days Ill Days in Bed	(n.s.) mother's or Hhold's (n.s.) mother's or Hhold's (n.s.) mother's or Hhold's	(+) father's education (+) father's education (+) father's education	(+) higher odds (+) longer (+) more severe
Household Diet				
#3 MI and acculturation will be associated with higher proportions of market foods in the household diet.	% of items from market	(+) but farm still most important	(+) school grade of head	(+) more in San Antonio
#4 MI will be associated with greater diversity of the household diet.	Dietary Diversity	(+) upper income hholds have highest, but difference is small		
#5 MI at household-level will be associated with greater access to market foods in lean periods.	% of market foods by season	(+) upper income hholds have higher access to market foods, but lower income hholds also increase market foods		(+) access and distance, market is seasonal alternative

(+) = positive association with dependent variable; (-) = negative association with dependent variable; n.s. = No statistically significant association at 0.90 level with dependent variable.

Table 9-1. Continued

Hypotheses	Dependent Variable	Market Integration	Acculturation	Community (San Antonio)
Nutritional Status				
#6 Children with more integrated and acculturated parents will have better nutritional status.	WHZ, HAZ, WAZ, and ZAMA	(n.s.) mother's (n.s.) household-level	(+) mother's, but small effect only; (-) father's for HAZ, WAZ	(-) younger children; (+) older children
#7 More acculturated and integrated adults will have better nutritional status.	BMI, WHZ, ZAMA, and Z2Skin	(n.s.) individual-level (+) hhold MI factor (+) hhold wealth (more for men) (-) hhold credit	(+) men only	(-) lower measures in San Antonio

(+) = positive association with dependent variable; (-) = negative association with dependent variable; n.s. = No statistically significant association at 0.90 level with dependent variable.

integration and perceived health to persistent conditions of poor sanitation, water insecurity, and lack of adequate access to preventative health-care services. Factors other than economic participation mediate health and likely play a more important role in determining self-perceived health status. Another possible explanation is that any economic resources (income, wealth, or credit) earned through greater individual or household integration into the market economy are not being invested directly into health benefiting goods and services (Haddad et al. 2002).

Measures of acculturation did not show signs of consistent directions of association with measures of self-perceived health. Higher levels of adult education were associated with lower odds of illness and shorter duration and severity among women only. Father's education predicted more illness and longer duration for children. The mechanism through which father's education would be detrimental to child health is less clear and will be addressed in a general discussion of acculturation. Mother's education may be too low to demonstrate health benefiting effects.

Household Diet

Essentially, the diet component of the study looked at whether changes in the way a population procures its food affects overall welfare. I looked at type, source, and diversity of foods in the household diet. There are marked differences by income groupings; households in the upper third of average monthly income use more market foods than households in the lower or middle income groupings.

The results of my analysis of household diet support the classification of Tsimane' as forager-horticulturalists. Small-scale agriculture supplies the bulk of the household diet in both communities. The distribution of secondary reliance on foods from the forest or market is largely dependent on distance (community) and access (distance as well as

trading or sale opportunities) to those foods. These features also pattern use of nonlocal foods during changes in seasonal availability of local food resources (Leonard 1989). A greater reliance on market foods during the lean/preharvest season noted in San Antonio suggests that market foods are important when farm and forest foods are scarcer. I found evidence to indicate that households in the upper income third have greater access to market foods during the lean season (cf. Figure 7-2). Nevertheless, the data imply that Tsimane' households in the panel study, even in the more integrated community, have not become fully dependent on the market as a source of food. Excluding the school teachers in each community, all households still manage agricultural plots as the principal means of food production.

From a quick appraisal, it appears that the more market-involved and exposed households are leaning toward shifting their dietary preferences yet I argue that even Tsimane' households in the more market integrated community (San Antonio) would have a difficult time transitioning to a completely market-based or purchased household diet because household and individual income are irregular. Only the professors in each community have a fixed monthly wage that allows regular patterns of food purchases. For the rest of the Tsimane' population, adequate subsistence depends on a multidimensional strategy of maintaining farm production, continuing to acquire forest resources, especially fish and game, and purchasing other necessary items such as salt in the local market towns.

The growing perceived need for market foods such as sugar and alcohol and greater desire for novel items such as bread and noodles were more apparent in San Antonio, particularly among the younger adult males. Tastes seem to be influenced by contact and

exposure to the larger society much more in the community closer to the market and among the younger generation. Values and preferences are socially constructed through exposure and acceptance of values of members of the dominant society.

Nutritional Status

The Tsimane' children in my study follow general patterns of nutritional status found throughout the Amazon region (Dangour 2003; Dufour 1994; Hodge and Dufour; Holmes 1985). There were no major indications of acute energy deficiency, but signs of long-term nutritional stress were present. Household-level measures of market-integration were not statistically significantly associated with child nutritional status. A community effect was apparent for two of the measures, but ran in the opposite direction for younger and older children. Among younger children, father's education had a negative association with both long and short-term measures of nutritional status. The opposite effects of parental education are interesting to consider. Some aspect of father's acculturation is associated with a negative impact on child nutritional status. The most highly educated men in the sample are the school teachers and two other young fathers who are away studying in the departmental capital. The time devoted to teaching and studying pulls these men away from traditional subsistence activities of farming and foraging wild resources (e.g., hunting and fishing), which could in turn affect availability of food resources to the household.

Adults in more market-integrated households show signs of better nutritional status. Specifically, household wealth shows a statistically significant association with nutritional status. This wealth effect appears to be gender-specific with Tsimane' men benefiting more than women. The gender division of domestic labor and market activities begins to explain this finding. Only men work in wage labor and they control

larger sums of cash income than women. Adults in the more distant community (Yaranda) are heavier and have greater fat reserves than adults in the closer community (San Antonio) suggesting that influences of contact, exposure, and assimilation to non-Tsimane' culture have some effect on nutritional status.

Market Integration

The variation in access to cash income that we encountered in the two communities challenged our team's initial expectations of what we would find in the field. While from one perspective Tsimane' adults and households are increasing their economic participation, the majority of them in our study are yet to become a full part of the market system. Access to well-functioning credit markets, regular income, savings, and health services are still elusive. Economic principles of risk management and risk avoidance through behaviors that smooth consumption (e.g., savings, reciprocity, marketing niche products during seasonal drops in demand for goods) are not widely practiced. Rather, Tsimane' households maintain a strong subsistence base in farming complemented with wild resources (to a lesser extent) to buffer seasonal fluctuations in income. Evidence from this study suggests that the market economy is also a viable alternative source of food resources during lean times.

The lack of significant relationships between measures of market integration and health suggest that income and wealth managed by Tsimane' households may not function as economists predict because income is irregular and not the principal strategy for acquiring resources. The precaution against shocks is farm production and forest resources. Income may not yet play a significant role in stratifying households to the point where differences in health and welfare emerge.

Moreover, agricultural production is one of the main vehicles by which individuals and households integrate into the wider market economy, through the barter and sale of agricultural products. Income from agricultural sales is not used exclusively for purchasing food, but is directed toward nonfood items for material wealth accumulation as well as tools for farming and hunting.

Apart from *jatata* palm panels, there is not a large or regular market demand for nontimber forest products extracted or manufactured by the Tsimane', and unlike other native groups living in tropical forests, the Tsimane' households we studied were not highly involved in any market for game meat. Cash income from sales and wage labor exhibits high seasonality. Many households in close proximity to the market town are actively expanding their agricultural production with the intent to sell large proportions of the harvest in the market. Higher incomes should predict greater access to more goods and services (Akin et al. 1985; von Braun et al. 1984). The goods and services bought with this income or acquired through barter are questionable as to their direct investment in individual or household health. This is an important, yet often omitted, factor to whether increased cash income will be directed to health-improving investments at the household and individual-level. The acquisition of educational training and skills and access to cash do not guarantee any return investment in health.

Looking ahead, intensification of commodity agriculture by households desiring cash and market goods could result in changes in subsistence patterns. Households that sell off all or the majority of their agricultural production eliminate their safety net of food security from the farm. By contrast, households that sell or trade fewer agricultural

goods or *jatata* have not changed production patterns in a way that they are demonstrating shifts in traditional diet.

Increased income through greater market participation and commercialization of agricultural goods and labor might not result in obvious child health improvements if spending patterns influenced by acculturation detour any income-food effect (Kennedy 1994). The absence of any simultaneous improvements in health infrastructure poses a persistent constraint. Additionally, the local market has not responded to the demand for health services created by the Tsimane' population.

The literature suggests that greater income at the household-level should be associated with investments in food consumption, access to clean water, hygiene, health care, and community-level sanitation (Haddad et al. 2002). My results indicate that moderate increases in income may not be sufficient to achieve these improvements. The short-term income we measured may not show any health effect, whereas longer trends in income over time would contribute more to understanding the potential income-health connection (Behrman and Deolalikar 1988).

What we see from the study of the Tsimane' is that income and wealth alone are insufficient to improve the health and nutrition of households in the two communities. More direct investments in health-benefiting goods and services such as prenatal care, vaccinations, improved shelters, and clean water at the community and household level are necessary (Kennedy 1994). These objectives likely require larger investments and behavioral changes directly linked to health such as improved hygiene, boiling of drinking water, and savings. Unlike findings from other societies, among the Tsimane' people, cash is not primarily directed toward wealth accumulation or insurance against

shocks – one of the potential mechanisms for cash to influence health (Behrman and Deolalikar 1988). There are many determinants of health for which my study did not account. Poor health infrastructure discussed in the previous chapters likely accounts for health outcomes. It may outweigh any income benefit or sustainable health improvements. From a theoretical standpoint, greater attention to the mechanisms through which greater integration in to a market system translates into changes in health status need to be addressed. Indeed, we found a wide range of levels of income and wealth on the sample, but not the corresponding differences in measures of health and welfare.

A gender component to market integration is apparent from this study. The descriptive analysis of individual adult economic measurements in Chapter 4 clearly demonstrated that within Tsimane' society men are the primary earners of cash income. Men account for almost all of the income earned from wage labor. Men are likely controlling the use of income as they are the direct recipients and the household members most likely to go to town. The small gender differences in the effect of wealth/income on adult nutritional status in Chapter 8 may be indicative of differential benefits of market integration. When the adult sample was disaggregated by gender, the effect of measures of market integration was found only for men.

Acculturation

The somewhat ambiguous effect of acculturation on health may indicate that the research design operationalized acculturation too much as a single dimension – education. In the literature review I acknowledged that acculturation is multidimensional, but the analysis relied primarily on education-related measurements. Results of the analysis of maternal education on child health suggest that the scales for

educational attainment, literacy, and language competency may be too narrow to represent any variation among adult women. Tsimane' women cluster at the lower end of educational measurements and any true differences in acculturation and exposure to the dominant society may not have been well-specified.

Our team's extensive work with translators informs us that even among those adults that can read and write in Spanish, there exists a wide range in abilities (Vadez personal communication 10/09/03). Scores of 0 to 2 do not adequately represent variation, something that we overlooked in the research design. Many of the conventional measures such as religion, literacy, education, and distance have little to no variance in our two-community panel study. Elsewhere, other scholars have found that low levels of educational attainment for women obscure any possible positive effect on child health status (Kennedy 1994). Paternal education was expected to have been associated with greater economic opportunities and skills as a means for positively affecting household welfare (Caldwell 1993). Parental education and other measures of acculturation pose an area for further research. A next step in the analysis of my data is to examine the data from the cross-section of 58 communities which represent greater variance in education and distance from the market influences.

Using measures of educational attainment and skills as proxy measures of adult acculturation may have also overlooked health knowledge and child care practices. There is likely not much health knowledge taught within the school curriculum. Contact with hospitals and management of child records of vaccinations are behaviors that may yield a better understanding of modern health knowledge. The low level of exposure to Western medical knowledge among the Tsimane' was not adequately represented in our

measures of acculturation. Evidence from epidemiological transitions in North America suggest widespread improvements in health rest on the dissemination of knowledge about germ theory, sanitation, and disease transmission (Tomes 1999).

Acculturation with the larger society is mediated through language and contact. The process of acculturation plays out at different rates depending on contact and involvement in wider activities and organizations as well. Apart from formal schooling, much of the skills training and organized community projects in the Tsimane' communities have been centered more around males, in part due to their already greater ability to communicate with non-Tsimane'. Another suitable measure of acculturation that we overlooked is political participation. Possession of a voter registration card or state identification card are two possible variables that might capture other aspects of involvement in the wider society.

Community differences

The range of measures of integration into the market within each community was wide, more than our initial selection indicated. At the same time, it allowed us to account for individual opportunities and differences within communities in earnings, assets, and acculturation. Community of residence had a significant effect on household diet, reported child illness, and both adult and child nutritional status. Residence in San Antonio was related to higher odds of illness, longer duration, lower measures of nutritional status, and greater incorporation of purchased foods into the diet. This cross-cutting finding in all three dependent variables signals that there is something that the study did not catch, or that residence or distance is one of the most valid determinants of individual health.

Based on ethnographic observation and analysis throughout the research period, I argue that values and preferences shaped by greater exposure to the larger society, be it economic or cultural contact with non-Tsimane' actors and institutions, affect how decisions about health are mediated. A distance effect embedded within the community variable generates and maintains the need for reciprocity and interdependence of households within a community. The stronger kin ties in Yaranda bolster these behaviors. Daily encounters with outsiders passing through San Antonio and other communities close to town qualitatively shape the features of the community interactions. The results suggest that community attributes mediate economic activity (e.g., *jatata* trade vs. agricultural labor) and acculturation in a way that explains differences in health outcomes. I intend to address this through the analysis of the 58 community cross-section data where I can hopefully tease out community-level factors to health.

Methodological Contributions

Research Design

The production of health is a complex, multifaceted process with an array of influences that are not easily measured. The decision to use random and fixed effects models in part addressed some of the unobservable attributes contributing to the production of health. The panel sample design represents a step toward more accurate data compared with many cross-section designs. Attempts to improve on our research design are encouraged, especially at the level of doctoral research, and will hopefully wash out the error found in cross-sectional analysis. Longitudinal study of the income of indigenous peoples is scarce and investment in this type of work is costly, but likely to lend insight into understanding the complexity of economic and social processes.

Research Team Approach

This research was made possible only through a team effort that pooled financial and human resources in the collection of data. Team components should be promoted at the level of graduate training to pool resources and better investigate research questions. Collaboration with colleagues across nations and disciplines and treating the field as a classroom enhanced the experience and the quality of this work, as well as each of the subtopics nested within the larger study. This approach, of course, requires sufficient resources, which may entail more work before going to the field. I believe that the days of the lone anthropologist are fading and giving way to the fostering of team approaches to scientific research in the social sciences. At our professional conferences, some may comment on the list of multiple authors and contributors on publications and presentations, but in fact, in this research each team member was actively involved in the development of research questions and data collection even though the analysis was more individual.

Areas of Future Research

From my experience with this study, I am able to arrive at recommendations for future research on indigenous health and integration into the market. One suggestion for future research stems from the difficulty in assessing variation in individual-level acculturation of indigenous people. Attainment of formal education and skills may not be suitable variables to distinguish between levels of assimilation and adoption of influences of the dominant culture among relatively unacculturated peoples. Education may not be the factor on which health knowledge and practices revolve. Efforts to develop instruments that would gauge specific health knowledge and behaviors would be useful.

One of the uncertainties in this study is attributed to the fact that we did not collect systematic data on individual and household expenditures in order to track the use of income earned in the market. Systematic data collection on household expenditure patterns would aid in answering questions about how newly integrating populations use cash income and wealth, whether they apply it toward direct investments in health or other goods and services that have neutral or detrimental effects on health. Reciprocity and social networks were not measured in our study either, factors of the community and household-level that likely come into play in determining Tsimane' health and access to care. In the more remote community, communal practices of food procurement and food sharing probably act as insurance mechanisms.

Further empirical data collection on energy expenditures and time allocation would contribute to teasing out the gender differences in adult measures of nutritional status. The gender division of labor may call for higher seasonality in men's energy expenditures. Data on energy expenditure would also address whether greater intensification of market participation is associated with higher or lower energy output for adults. Other scholars have addressed this issue, but it was beyond the scope of this research design. In-depth seasonal analysis is another future analysis that I intend to conduct.

I encourage further empirical work that focuses on well-specified measures of market integration, acculturation, and health status. Clinical assessment and other objective measures of health when possible contribute to understanding how the health of populations is affected by integration and acculturation. Longer-lag times between income and health should also be explored. Clarification of the impact of the ecological

conditions in which the Tsimane' live is useful. Likewise, micro-level studies of the ethnic group, village, household and individual need to be well-specified because broad results of national-level studies are not readily transferable to the micro-context.

Finally, the assumed paths or mechanisms through which market integration and acculturation relate to health outcomes need to be addressed in greater depth. Access to income whether cash or in-kind, accumulation of wealth, educational attainment, and language proficiency do not necessarily translate directly into changes in health status. Theoretically, each of these factors has the potential to indirectly affect human welfare. However, decision-making about allocation of these human and physical capital assets is also involved.

More research is necessary into whether indigenous groups with longer histories of integration ever reach a point at which they are fully participating in market systems or if they remain economically marginalized and market dependent. At present, there is not sufficient evidence that Amazonian groups are reaping the proposed benefits of incorporation into the market economy. The impact will surely vary over time and intensity.

Policy Recommendations

This study reveals that Tsimane' access to health-care facilities and preventative services such as vaccinations and prenatal care could be strengthened. Poor service delivery and lack of cultural sensitivity to the economic and social circumstances of the Tsimane' on the part of the urban health care providers was apparent. Needs assessments and research on the constraints to accessing services should involve an examination of political and economic obstacles. Relationships between the San Borja municipal government and the Gran Consejo Tsimane' or Ministry of Education could foster

partnerships to address the unmet needs of the Tsimane' population. But in the political and economic climate of Bolivia today, the needs of the least integrated groups such as the Tsimane' are not high priorities on the political agenda. Political support for initiatives to better serve the native lowland population is necessary. There have not been any sustainable health programs involving the Tsimane' sponsored by NGOs or the local government. It is an area that could be tapped, however, the mistrust and history of poor follow through discussed earlier in the dissertation is a significant obstacle to overcome.

Integration and Acculturation in Motion

While the processes of social acculturation and integration into the market economy bear an increasing influence on Tsimane' culture, there is certainly variation in the degree and nature of influence both within and between communities. Social and economic forces continue to act on the traditional Tsimane' livelihood. During my field research, I observed first-hand increases in economic and social behaviors stemming from market involvement and exposure to the dominant social values of the region. Our research team witnessed the intensification of sales of alcohol, the literal and symbolic commodity of domination in Tsimane' history, between community members for profit. The introduction and abuse of alcohol has been intensified through contact initiated by frontier development initiated contact (Ramos 1984). There are notable differences in behaviors of distribution of goods within the two study communities. In the community closer to the market town (San Antonio), market-acquired commodities are sold between relatives rather than shared. At a cursory level, attitudes about food sharing also seem to differ, with less redistribution and reciprocity in the more market-oriented community. This can be attributed to weaker kin ties among households, greater adoption of values of

independence, desire for wealth accumulation, and shifting food procurement strategies that favor individual over communal participation.

Since my initial 18 months (1999 to 2000) of residence among the Tsimane', I have returned to Yaranda and San Antonio on two different occasions, once in June 2001 for month of follow-up research and a second social visit in August 2002, lasting only a few days. Each time, I have observed notable changes in physical infrastructure and articulation with the wider economy and society. As of 2002, a water project was implemented and completed in San Antonio. The project resulted in supplying hand-pump water wells for every two households; a goal that seemed so elusive during my tenure in the community.

The virtual distance between communities on the upper Maniqui River and San Borja is shrinking. In 2002, five Tsimane' communities along the Maniqui River were recipients of donated short-wave radios powered by solar panels. Yaranda was one of the fortunate communities. The radio aids in emergency contact as well as regular communication with the Gran Consejo Tsimane' in San Borja and other communities equipped with radios. It was remarkable to witness the change in daily communication. There is even a rural telephone in the Tsimane' community immediately downriver from San Antonio (Campo Bello). It is accessible only through prepaid cards purchased in town and most likely is not used by anyone. It appears to have been a pet project of a misdirected politician or development organization. Nevertheless it carries considerable symbolic value.

There are also several new households in San Antonio, reinforcing the pattern of resettlement of households closer to the market town. One of the two brothers from San

Antonio that studied on scholarship in the departmental capital of Trinidad was elected *Sub-alcalde* (Vice Mayor) of his district. This is a significant step toward greater Tsimane' participation in local politics.

While there is great variation captured in measures of integration to the market, we have a view of a subgroup of Tsimane' living at a significantly different level on the curve of income and wealth accumulation. Members of the Gran Consejo Tsimane' make up the Tsimane' elite class. Their adoption of *camba* standards of material wealth displays are apparent. Whether or not the Consejo serves as an accurate glimpse into the future of Tsimane' social acculturation and integration into the market economy is uncertain, but undoubtedly their behaviors have been heavily influenced through economic change. Greater perceived material needs by members of the Consejo and in the communities are evident. Tsimane' adult males are more of the vehicle of change than women.

I did not find evidence of major declines in perceived health, diet, or nutritional status associated with greater involvement in the market economy and acculturation with the regional society. Yet at the same time, I neither found evidence that these dynamic processes are leading toward noticeable health benefits or improvements in the living standards and welfare of Tsimane' individuals and households. Despite the absence of strong statistical associations between measures of market integration, acculturation, and Tsimane' health, social and economic changes in Tsimane' culture are not going undocumented. If in fact there is a gradual process of social-disintegration underway among the Tsimane' in the more integrated and acculturated communities, what predictions can we make for the future? The Tsimane' of ten years from now may look

quite a bit different from what we studied from 1999 to 2000. These differences may widen both within the ethnic group with residents of communities closer to market centers becoming more interdependent on the market economy as well as the younger generation of adults adopting market social and economic values. I surmise that these changes are occurring more rapidly in communities with the greatest frequency of contact with nonindigenous actors.

APPENDIX A
KEY CONCEPTS TO LOGIT MODEL

Logit Model

Logit(π) = log of odds → log (π/1- π)

Logit (π) = $\alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \ldots\ldots\ldots + \beta_k x_k$

e^{π} is the multiplicative effect on the odds.

$e^{\alpha + \beta 1x1 + \beta 2x2 + \beta 3x3 + \beta 4x4 + \ldots\ldots\ldots + \beta kxk}$

Odds and Odds Ratios

Odds = (π/1- π) = $e^{\alpha + \beta} = (e^{\alpha})(e^{\beta})^x$

Odds ratio (θ) = odds of success/odds of failure

Success = reporting illness

Failure = reporting no illness

Interpretation of coefficients

if $\beta > 0$, then the probability of y [π(y)] increases as x increases.

if $\beta < 0$, then the probability of y [π(y)] decreases as x increases.

if $\beta = 0$, then there is no effect on probability of y [π(x)] as x increases or independence

Example:

$e^{\theta} = e^{0} = 1.0$ → no effect, odds ratio of 1, odds remain constant as x changes

Interpretation of Odds ratios

$\theta > 1.0$, the estimated odds of success are increased by a factor of θ

$\theta = 1.0$, the estimated odds of success are unaffected.

$\theta < 1.0$, the estimated odds of success are decreased by a factor of θ

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BIOGRAPHICAL SKETCH

Elizabeth Byron was born in Orange, California in 1973 to Dr. Roger and Carolyn Byron. After graduating from Villa Park High School in 1991, she moved to Durham, North Carolina to attend Duke University. She received her Bachelor of Arts in Comparative Area Studies from Duke University in 1995. From 1996 to1997, she taught English in Machala, Ecuador as a World Teach Volunteer. Upon return from Ecuador, she entered the Department of Anthropology at the University of Florida in August 1997. She returned to Ecuador to research her masters thesis on the impact of women's participation in an income-generating project on intrahousehold decision-making in Manabí, Ecuador in 1998. Soon after earning her Master of Arts from the Department of Anthropology at the University of Florida in May1999, she departed for 18 months of fieldwork among the Tsimane' Amerindians in lowland Bolivia. She continued her academic coursework and research analysis in Gainesville, Florida from 2001 to 2003.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Doctor of Philosophy.

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